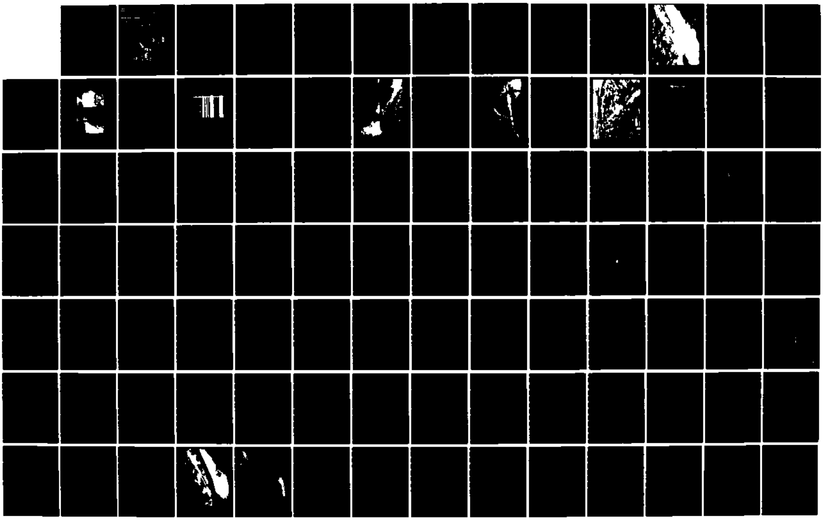
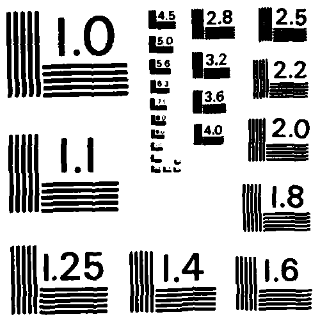
AD-A148 351 FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT WISCONSIN RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 83 1/9

UNCLASSIFIED F/G 13/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

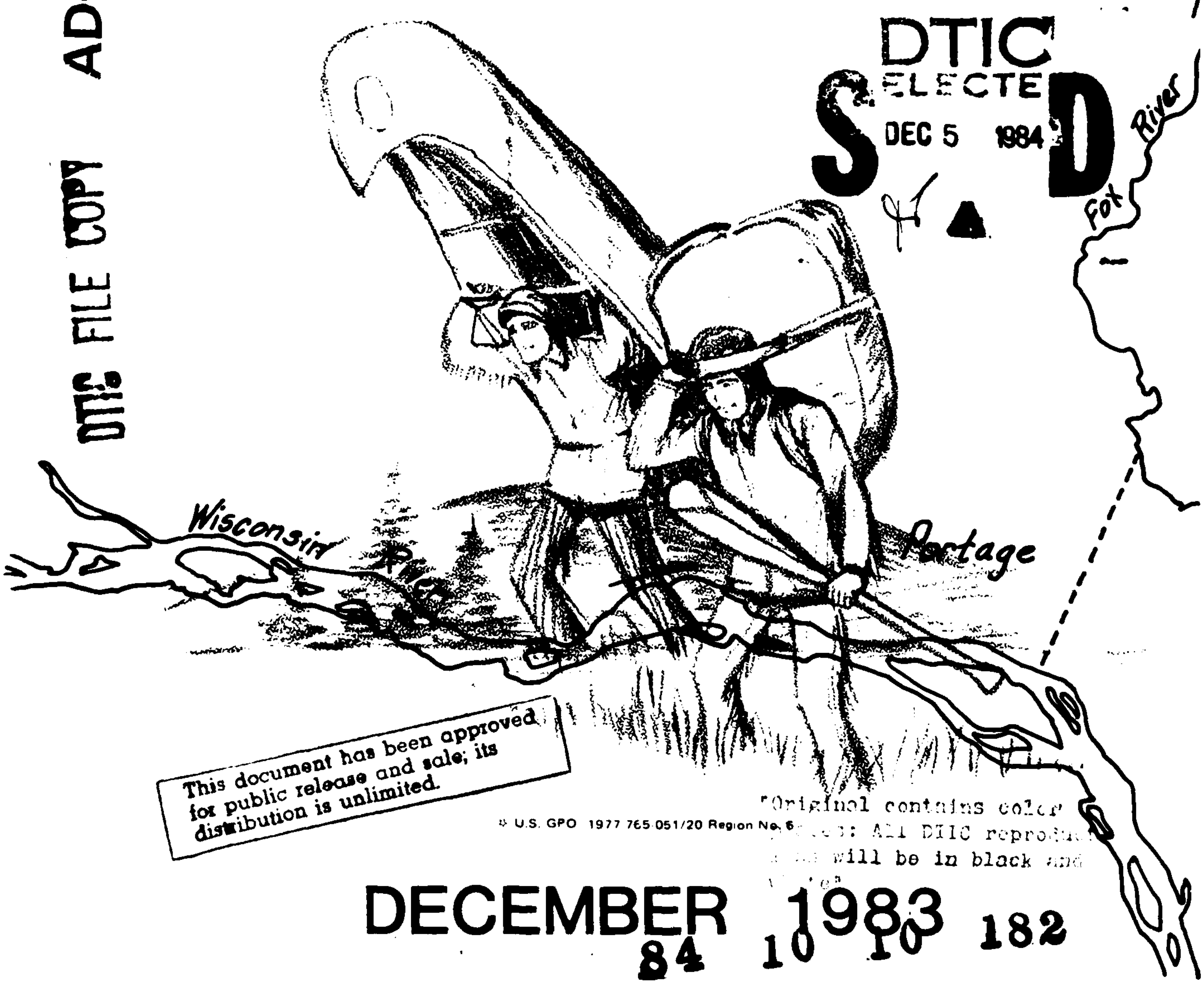
U.S. Army Corps
of Engineers
North Central Division
St. Paul District

FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT

Wisconsin River at Portage, Wisconsin

feasibility study for flood control

APPENDIXES



☆ U.S. GPO 1977 765 051/20 Region No. 6

DECEMBER 1983

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A148 351	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FEASIBILITY STUDY FOR FLOOD CONTROL WISCONSIN RIVER AT PORTAGE, WISCONSIN. APPENDIXES; Feasibility report and final environmental impact statement.		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. ARMY ENGINEER DISTRICT, ST PAUL 1135 USPO & Custom House St. Paul, Minnesota 55101-1479		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE December 1983
		13. NUMBER OF PAGES 790 pages
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

FLOOD CONTROL
WISCONSIN RIVER
PORTAGE, WISCONSIN

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The appendices accompany the main report with develops a flood control plan for the Portage, Wisconsin area, in those areas affected by the Wisconsin River and backwater flooding in the lower reaches of the Baraboo River and Duck Creek. The appendices are: Appendix A--Plan Formulation; Appendix B--Hydrology; Appendix C--Hydraulics; Appendic D--Interior Flood Control; Appendix E--Geotechnical Investigations; Appendix F--Social and Economic Analysis; Appendix G--Cultural and Environmental Resources; Appendix H--Recreation and Landscape Beautification; Appendix I--Design and Cost Estimate;

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

84 10 10 182

APPENDIXES

FEASIBILITY STUDY FOR FLOOD CONTROL

WISCONSIN RIVER

at

PORTAGE, WISCONSIN

APPENDIX A

PLAN FORMULATION

December 1983

APPENDIX A
PLAN FORMULATION

TABLE OF CONTENTS

APPENDIX A

PLAN FORMULATION

TABLE OF CONTENTS (Cont.)

FIGURES

APPENDIX A

PLAN FORMULATION

FIGURES (Cont.)

APPENDIX A
PLAN FORMULATION

GENERAL

The plan formulation process involves identification of water resource problems, needs, concerns, and opportunities; identification and development of alternative measures to meet those needs; assessment and evaluation of alternatives; refinement of alternatives recommended for further study; and selection of a recommended plan. Problems, needs, and opportunities were identified from past studies and published reports, through various meetings, by exchange of correspondence, and through discussions with individuals and Federal, State, and local representatives. Alternative measures to satisfy the critical and most urgent water resource needs were cooperatively delineated, evaluated, and refined with local and State interests. Selection of a final plan was dependent upon the formulation process and the interactions with local interests.

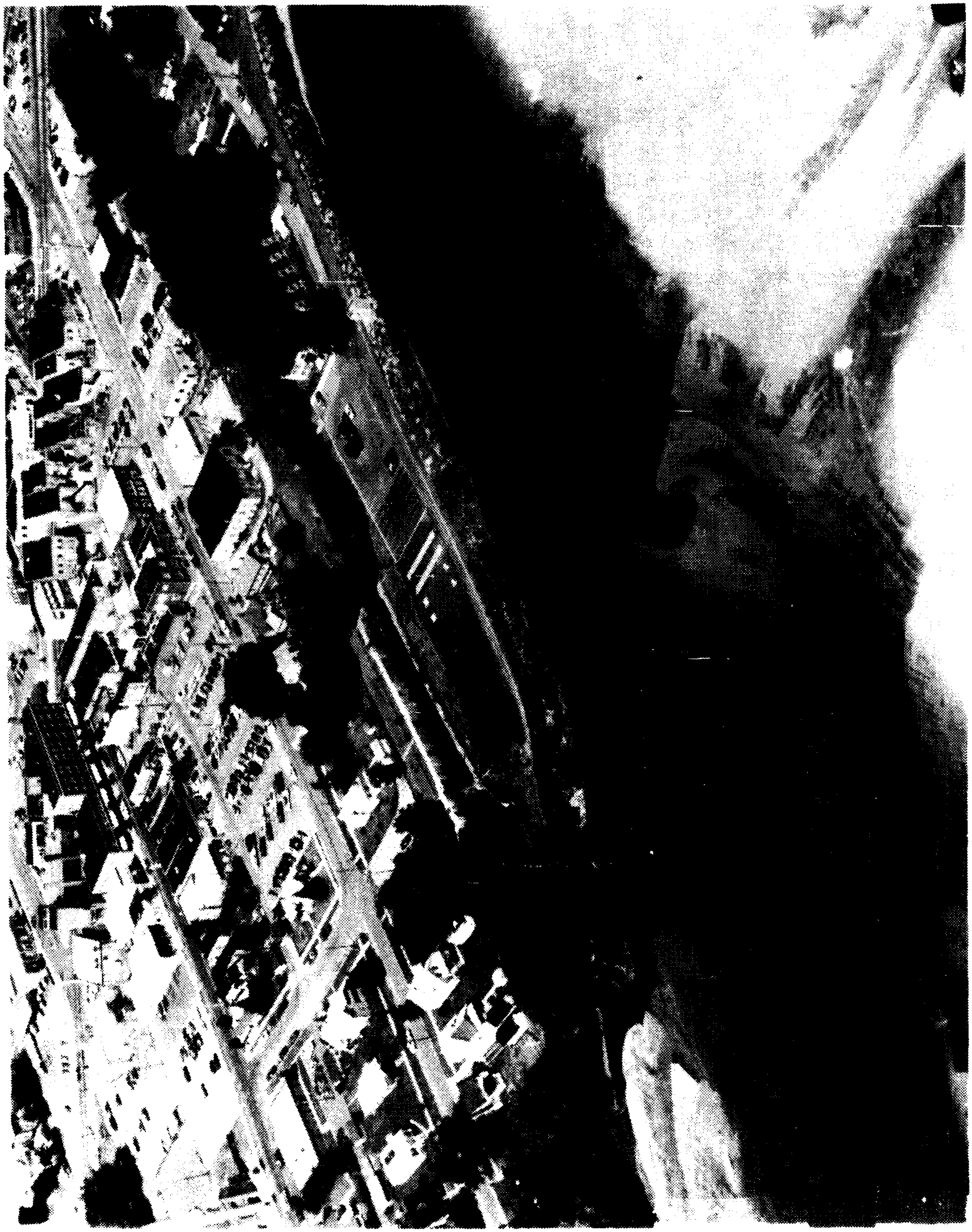
PROBLEMS, NEEDS, CONCERNS, AND OPPORTUNITIES

The primary concern expressed by the public is the control of floods on the Wisconsin River. From the mid-1800's until now, the Federal Government, the State, and the local interests have worked individually and cooperatively to reduce the magnitude of the floodwaters. Still, flood problems remain and there is a definite need to provide a solution to the flood potential that exists within the study area.

When the study began in 1976, pertinent concerns were identified over the floodplain regulations which had been adopted based on floodplain information reports for the Wisconsin River (Corps of Engineers, 1972 and 1975) and U.S. Geological Survey floodprone area maps. The hydrology and hydraulic analysis on which the regulations were based was

contested by a group of local citizens. The Wisconsin Department of Natural Resources and the U.S. Geological Survey expressed a need for a low-flow analysis on the Wisconsin River. As a result of these concerns, various interests saw this study as an opportunity to conduct an interagency hydrologic and hydraulic analysis of the existing conditions.

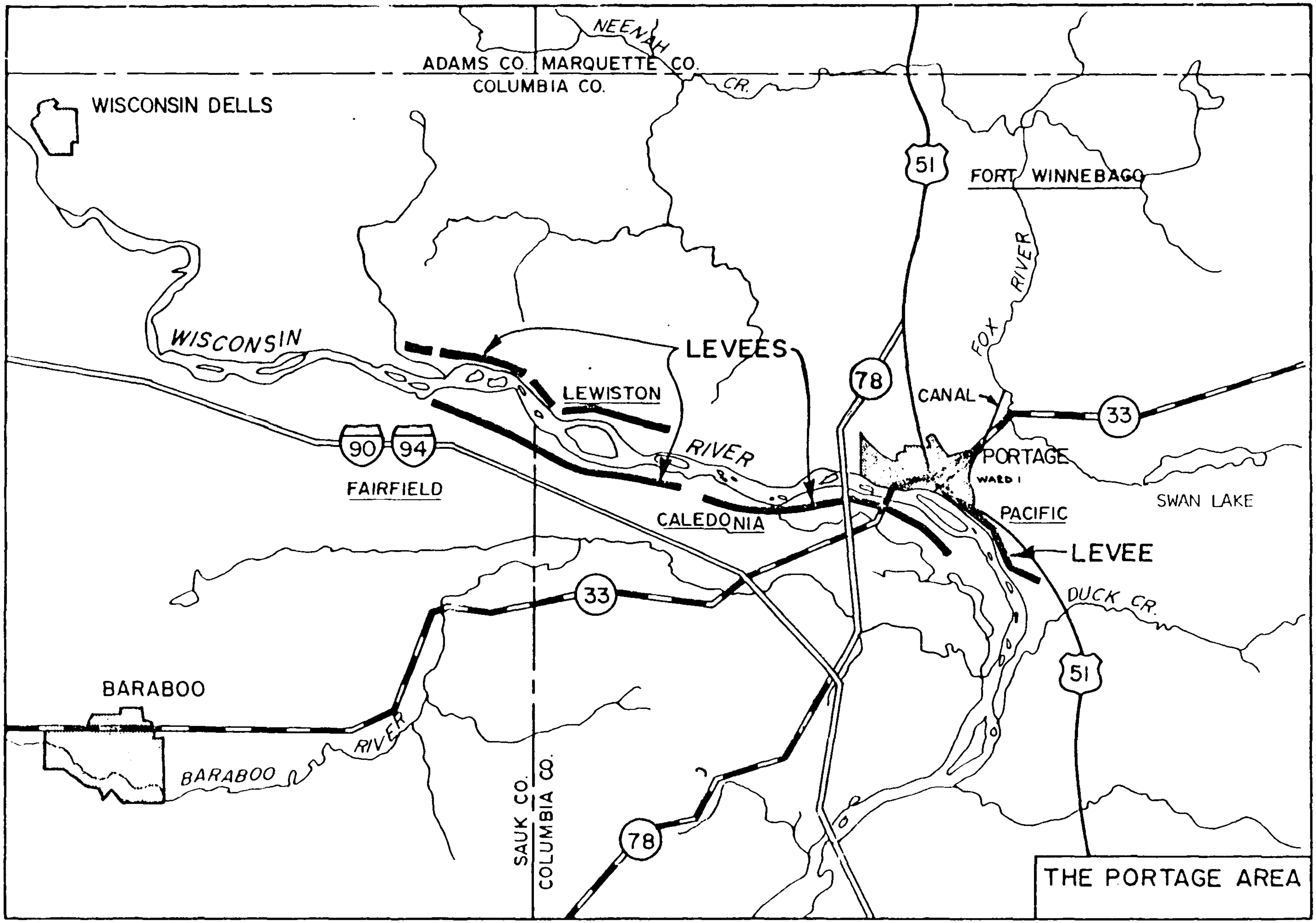
During the study, the Portage Canal became a registered national landmark, and strong local interest was expressed for restoring the canal. The Portage Canal Society has been actively seeking support from the Corps of Engineers since 1977. Because a flood control project at Portage would involve the canal area, additional studies were needed to determine specific ways in which the canal could be made a functional part of the project and still maintain its historic character. The Portage levee, canal, and lock are shown on the following figure.



Portage Levee, Canal, and Lock - 1983

Although all of the various agencies and the public in Columbia County are vitally interested in having the study completed, there is a desire by many that suggests all of the floodprone areas must benefit from development of a flood damage reduction plan. Should a feasible plan for flood control be developed for only a portion of the floodprone area, public opposition may occur in areas not receiving added flood protection. Based on a 1982 Institutional Analysis, concerned citizens in adjacent townships have documented this expressed opposition, "Any increase in flood stages in adjacent areas as a result of single area flood protection will be carefully scrutinized in terms of the existing floodplain regulations and could likely lead to litigation."

The State of Wisconsin, Department of Natural Resources, currently maintains the existing levee system for Portage, Lewiston, and Caledonia (see the following figure). This is the only levee the State maintains. The State has indicated a willingness to continue to maintain any levees not recommended for upgrading in this study. Without the formation of a special District, the State's Constitution prohibits the Department of Natural Resources from acting as a local sponsor for a flood control project. Although local interests have indicated a preliminary willingness to sponsor a project, they would very much like to see the State act as the local sponsor for any proposed improvements.


THE PORTAGE AREA
WISCONSIN DELLS
ADAMS CO.
MARQUETTE CO.
COLUMBIA CO.
NEENAH CR.
FORT WINNEBAGO
FOX RIVER
CANAL
PORTAGE
WARD I
PACIFIC
SWAN LAKE
LEVEE
DUCK CR.
LEVEES
LEWISTON
WISCONSIN RIVER
CALEDONIA
FAIRFIELD
BARABOO
BARABOO RIVER
SAUK CO.
COLUMBIA CO.
51
33
78
90
94

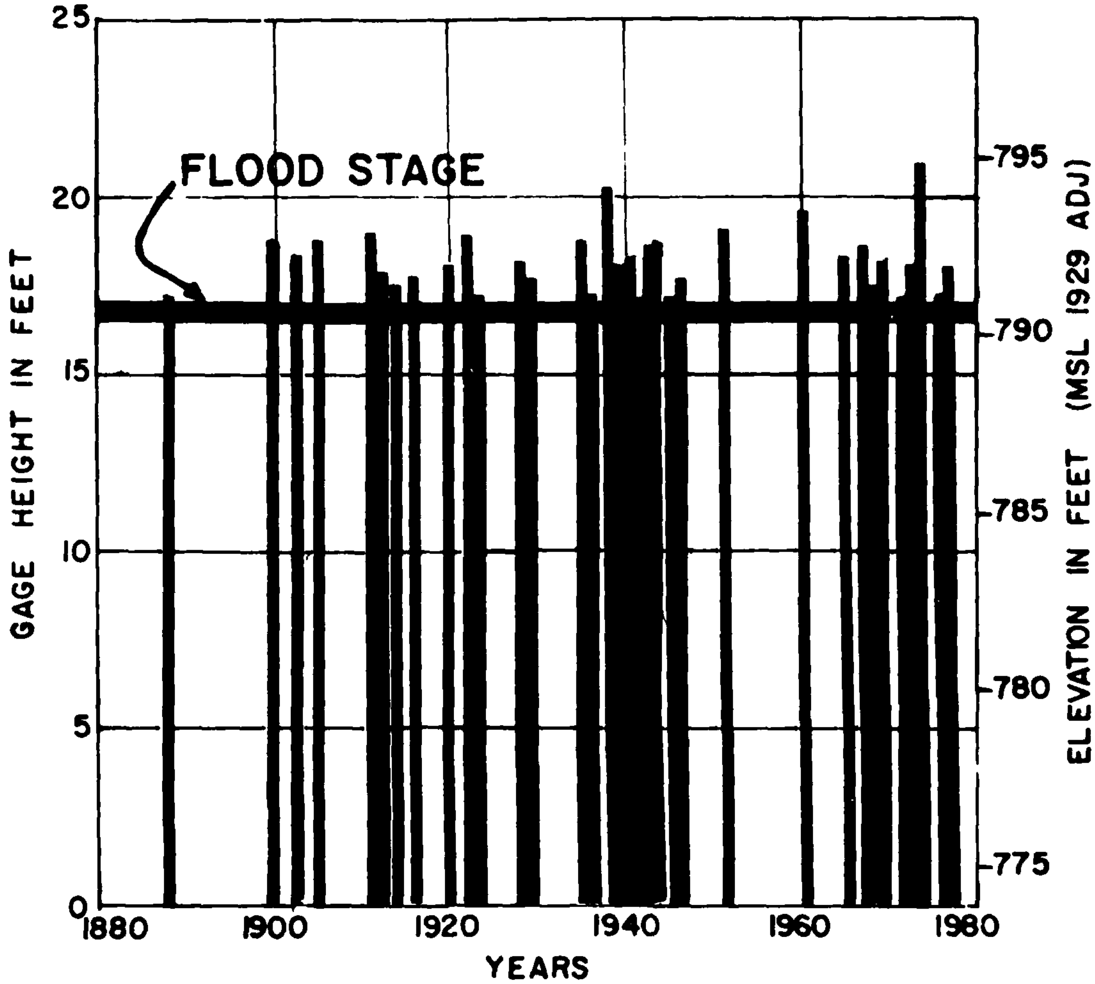
FLOOD PROBLEMS

Floods on the Wisconsin River result from snowmelt runoff and from rapid runoff following intense rainfall. Spring floods produced by snowmelt and rainfall occur with about the same frequency as summer floods produced by rainfall alone. Floods last up to 8 days on the Wisconsin River in the vicinity of Portage. Scenes from the 1938 flood are shown on the following figure.

1938 Flood, Portage, Wisconsin

The first record of river stages at Portage dates from March 1873 when a staff gage was established at the Portage Canal lock by the U.S. Weather Bureau (now the National Weather Service). The gage is read daily by a resident of the city. A U.S. Geological Survey water stage recorder has been measuring flow since 1934. This gage is about 3 miles downstream of Wisconsin Dells and 11 miles upstream of the study area limits.

Significant high-water periods occurred in 1880, 1900, 1905, 1911, 1922, 1935, 1938, 1943, 1951, 1960, 1965, 1967, and 1973. The years in which river levels were above flood stage (17.0 feet at the Portage lock) are shown on the following figure.



GAGE IS ON LOCKS IN PORTAGE, WISCONSIN AT MILE 115.0 ABOVE THE MISSISSIPPI RIVER

STAGES ARE ADJUSTED TO PRESENT GAGE ZERO OF 773.94 FEET MSL 1929 ADJUSTMENT

FLOWS ABOVE FLOOD STAGE

WISCONSIN RIVER
PORTAGE, WISCONSIN

During the early floods, the Wisconsin River overflowed into the low marshy land on both sides of the river a few miles upstream and downstream of Portage. Overflows to the south entered the Baraboo River and overflows to the north entered the Fox River.

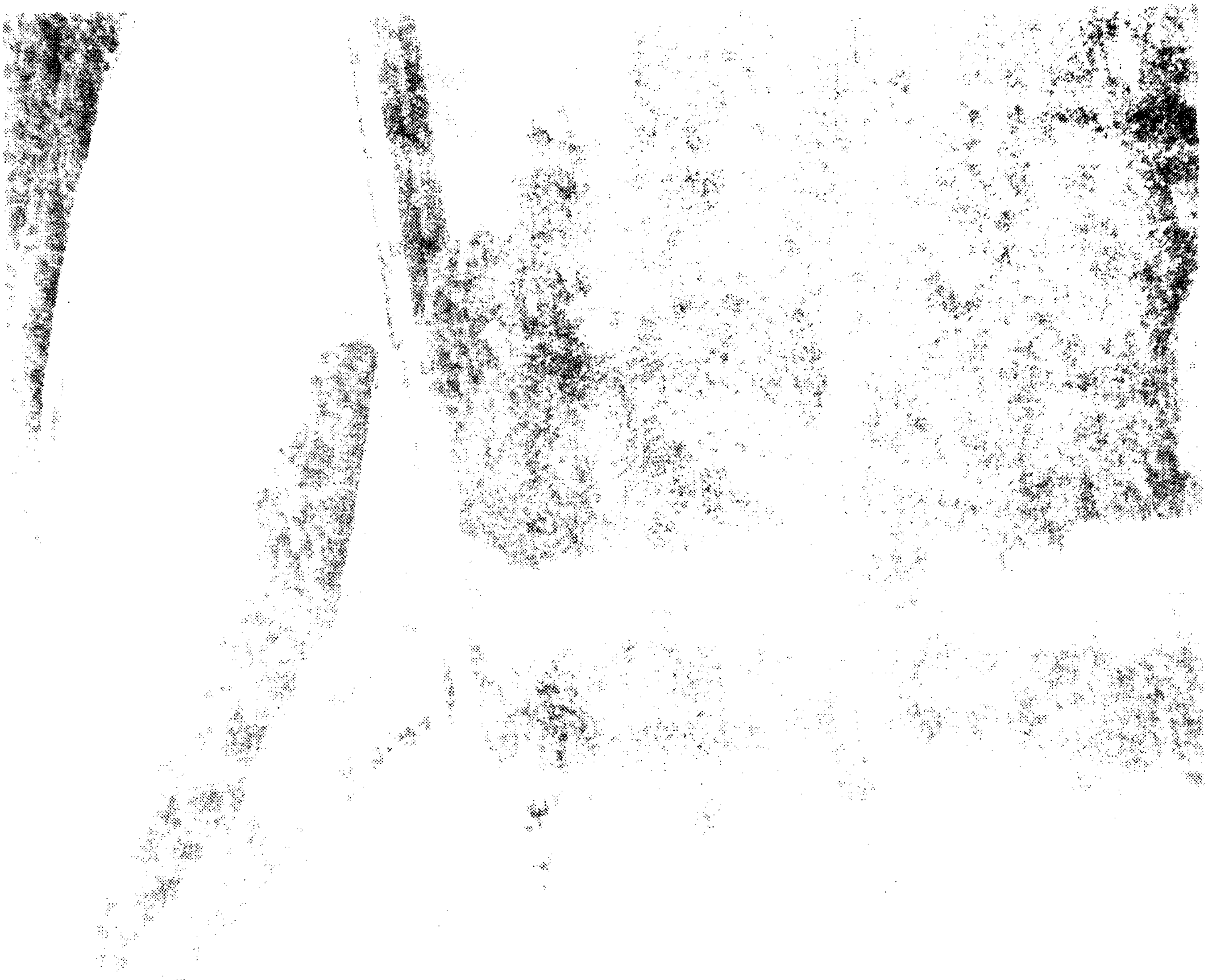
From 1866 to 1880, farmers from Lewiston constructed a series of small levees for local protection. After a damaging flood in 1881 the levees required repair. This work was done by Lewiston, the State, and the Federal Government. Most of the money for construction was provided by a drainage fund from the sale of marshland. In 1885, a levee was constructed on the south bank of the Wisconsin River to protect lands to the south and east. This levee was paid for by the township of Caledonia, also from the sale of marshland.

The confining of floodwaters by levees on both sides of the river upstream of Portage and the loss of flood storage in marshlands raised the height of floods at and below Portage. Thus, another levee was constructed but this time to protect the city of Portage. This levee was completed by the Federal Government in 1890 at a total cost of $18,000. The Portage levee caused floodwaters to flow more freely on the south bank of the river opposite the city. In 1891, a levee was built on the south bank below the Route 78 bridge. This levee was paid for from the sale of marshlands.

In 1901, the Portage Levee Commission was established to maintain, raise, and extend the levees. The Commission was abolished in 1961 and its duties were made the responsibility of the State. Today the levee system consists of a 13-mile reach of discontinuous sand levees along both sides of the Wisconsin River upstream, in, and downstream of Portage. The total length of the levees is almost 18 miles. The 9½ miles of levees on the south bank of the river is referred to as the Caledonia levee and prevents the flooding of some small farms, Interstate 90-94, and the Pine Island State Wildlife Area. The 5-mile Lewiston and the 3½-mile Portage levees on the north bank reduce the potential

flooding of city property, farmland, highways, the railroad, and the Fox River basin. The following figures are photographs of the Portage, Caledonia, and Lewiston levees.

Portage Levee and Old Levee [illegible]

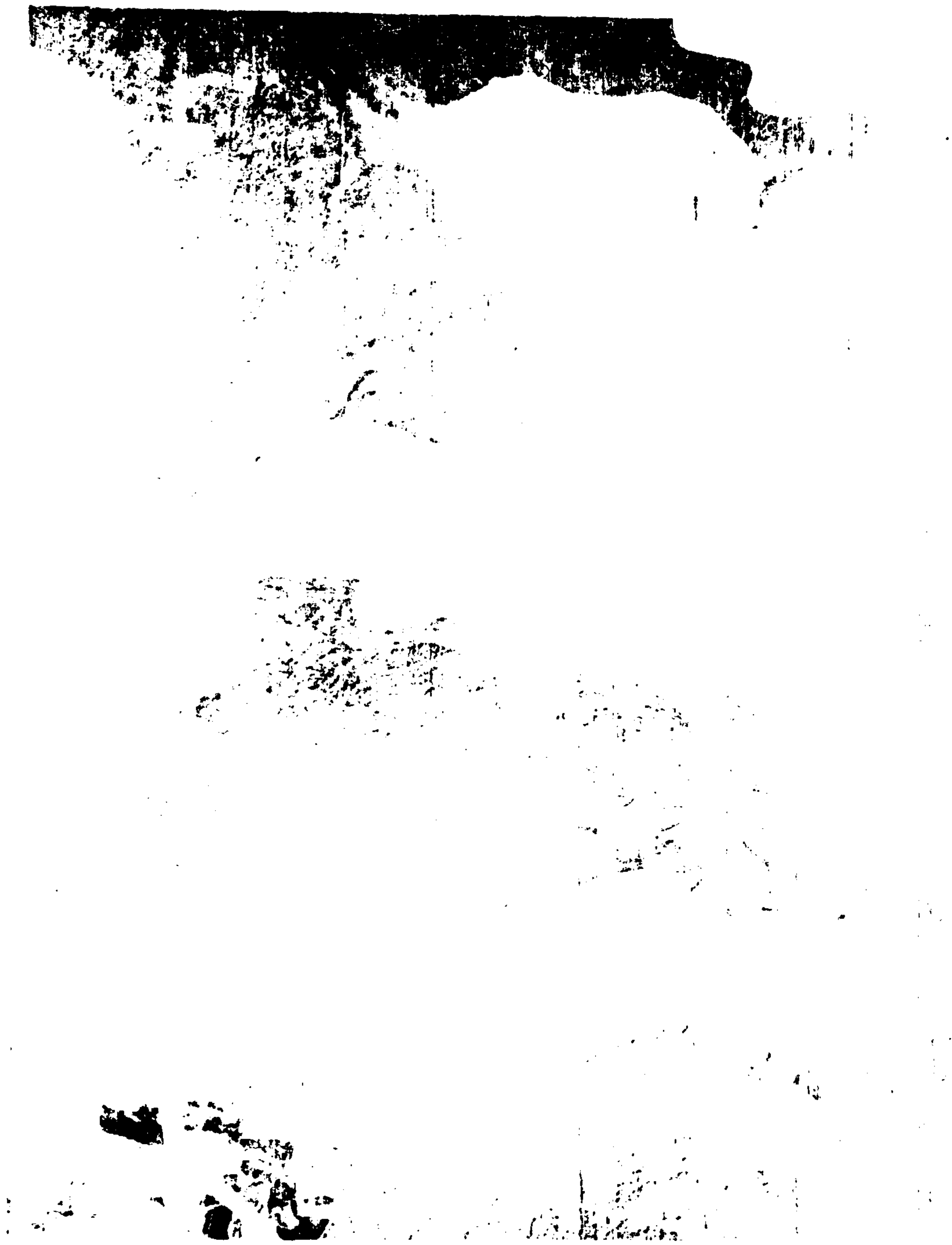


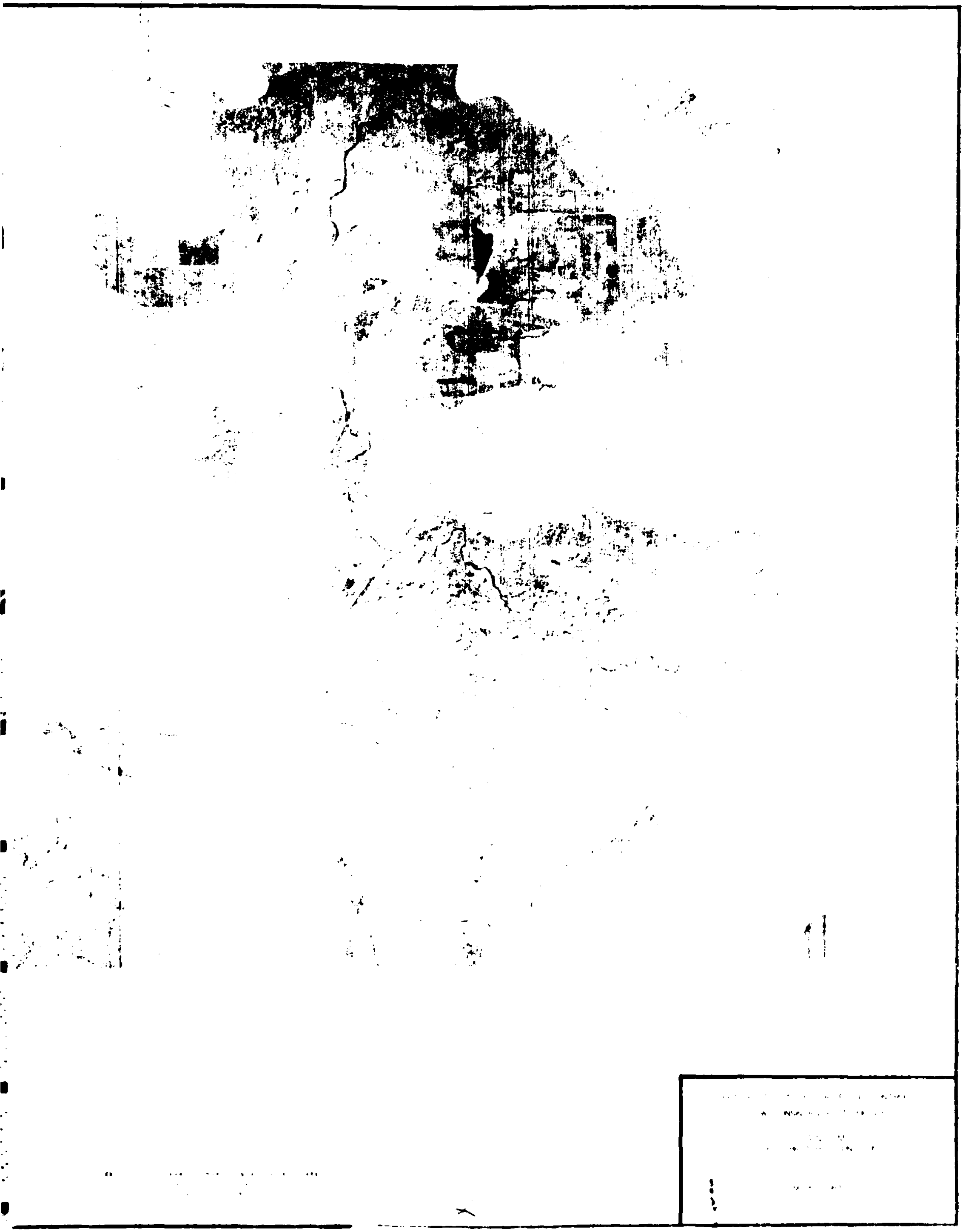
The largest recorded flood occurred in September 1938 and had a flow of 72,200 cfs (cubic feet per second). The stage at the Portage locks was 20.5 feet, or 795.6 feet above mean sea level. The Portage levee was breached by a 20-foot-wide gap which resulted in widespread flooding. A school bus was reported to have been placed in the breach and is said to be still there. After this flood the levees were raised about 2 feet above that high water surface at all points. This was the last documented raise of the levee system. The southern end of the Portage levee was extended about 1,000 feet in 1969 under the Corps flood emergency authority.

Overall, the levees are not reliable. Small breaches in the levees occurred in 1971 and 1973 with overtopping in 1938. The levee system was built haphazardly over a 100-year period as money became available or when the river threatened to breach a section. Based on soils analysis of borings (see appendix E) and a comparison of 70 levee cross sections with standard Corps design, the existing levee system cannot be certified adequate for any degree of protection. A more thorough discussion on the adequacy of the levee system is provided in the main report.

Basement flooding has occurred regularly in the first ward in Portage. The Ward 1 area (see the following figure) is bounded by the canal, the levee, and the eastern side of the city limits. This is the primary potential urban damage location within the study area. Minor flooding also occurs in Portage along West Edgewater, West Carroll, and Conant Streets near the Wisconsin River, an area with no levee protection, and in the Pauquette Park area near the Highway 33 bridge. Blackhawk Park, located across the river from Portage between Long Lake and the Wisconsin River downstream of the Caledonia levee, is also flooded regularly. However, many of the homes there are seasonal and are elevated on timbers or concrete blocks. The figure on page A-17 shows a general map of the floodprone area within the Portage area.

Ward 1 (to the right of the college [illegible]





At normal stages, the Wisconsin River at Portage is about 6 feet above the Fox River. At flood stages this difference can increase to as much as 20 feet. If the levees were breached or overtopped, floodwaters would travel overland into the Fox River basin, less than 2 miles away.

Flood damages from Wisconsin River overflows have been reported to occur in communities along the upper Fox River, although no damages have occurred in recent years. The flood of June 1880 sent a large volume of Wisconsin River water down the Fox River via the lowland in the Portage area. Damage in the hundreds of thousands of dollars was sustained in the Fox River valley, and the Milwaukee District Engineer at the time believed that a significant part of this damage was due to Wisconsin River overflows. The 1938 flood also resulted in significant overflow to the Fox River because of the breach in the Portage levee.

OTHER WATER RESOURCE PROBLEMS

Consideration was given to other potential water resource related problems within the study area. No other significant problem was discovered, as identified in the following summary table.

Summary of water resource problems

Problem	Discussion	Comment
Erosion and sedimentation	- Soils are slightly erodible - Sediment yield for the basin is low - No concerns raised by local interests	No significant problem
Water supply	- Most areas rely on groundwater - Groundwater supplies are abundant - Treatment may be a problem in developing future supplies - No concerns raised by local interests	No significant problem
Water quality	- Existing wastewater treatment plant at Portage is overloaded - Portage is constructing a new plant - Surface waters are OK - No concerns raised by local interests	No significant problem once Portage completes construction of a new wastewater treatment plant
Navigation	- No commercial navigation exists - No concerns raised by local interests	No significant problem
Hydropower	- Existing hydropower plant with limited additional capacity - No desire for development of hydropower potential	No significant need
Recreation	- Trails and access public waters are limited - Restoration of the Portage Canal is desired - No major concern expressed by local interests	Minor need

STUDY OBJECTIVES

The general planning principles and guidelines for conduct of a feasibility study require that all federally assisted water resource projects be planned to further the national objective of national economic development (NED). This objective consists of developing the most cost effective solution from a national viewpoint (i.e., the plan with the greatest net economic benefits). According to the guidelines, the solution must also be developed "consistent with protecting the nation's environment pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements."

The specific study objectives are derived from the problems stated in the previous section and are identified compatible with the national objective:

a. Provide an acceptable flood control plan for Portage consistent with the historic and environmental importance of the area.

b. Develop a hydrologic and hydraulic analysis of existing floodplain conditions which will provide a basis for floodplain regulation and flood insurance. (This objective was accomplished, based on the floodplain analysis completed for this document. As a result, local regulations have been updated and an updated flood insurance study is completed.)

The Wisconsin Department of Natural Resources has indicated that the study should:

a. Develop a hydrologic and hydraulic analysis as outlined in the interagency scope of work, including evaluation of the effects of upstream reservoirs, storage, and interbasin flow, and delineate the hydraulic floodways in the Portage area.

b. Consider levee protection for Portage along the south bank of the river and along the north bank upstream, downstream, and in Portage.

c. Consider relocating structures in the city on the south bank of the river.

d. Consider fee title purchase of flooded lands.

Item a has been accomplished. The other items were considered in the analysis of alternatives.

Local citizens have requested that the study consider the following:

a. Reevaluate the methodology of river flow rate determinations between Wisconsin Dells and the Prairie du Sac Dam and report to the committee. The methodology should be consistent with river flow history while considering the storage capacities of upriver dams and reservoirs and changes in flow patterns.

b. Determine the discharge capacity of the river at Wisconsin Dells through a hydraulic study to be balanced against the hydrology of the downstream area to the Prairie du Sac Dam. A study of the hydraulic conditions of the narrows at the Dells should be included.

c. Study the downstream reservoir capacity and storage in low areas outside the levees and simulate storage area effects by assuming topping of the levees but not their destruction.

d. Use data gathered by railroad engineers and the Wisconsin Department of Transportation on the history and effects of the roadbed and highway fills on water flow patterns.

e. Consider channel improvements and maintenance, including removal of sandbars and islands, use of wing dams, and control of brush and tree growth in the floodway between levees.

f. Check the effects of the Baraboo River regarding interplay on areas of consideration.

g. Check the effects of the Fox River regarding interplay of separate river basins in the area of consideration.

h. Check the hydraulics of the Fox River valley and the impacts of Wisconsin River overflows into the valley.

i. Evaluate the operation of the Prairie du Sac Dam spillways within the constraints of the Public Service Commission.

j. Evaluate and recommend operating procedures for the Castle Rock and Petenwell Dams and Reservoirs within the constraints of the Public Service Commission.

k. Evaluate the following alternatives.

(1) Construct and maintain levees for total protection of all property or a lesser degree of protection to minimize damage to property downstream or consider control structures to bypass excessive flows.

(2) Consider available soils for levee construction and maintenance.

(3) Determine what flow can most cost effectively be contained within the levees through Fairfield and Newport downstream to Lake Wisconsin and how to handle excess flows above that amount.

Items a through j were investigated in the hydrology and hydraulics appendix (30 July 1980). Item k is discussed in this appendix.

PLANNING CONSTRAINTS

Any flood damage reduction measure(s) or plan identified for all or part of the study area through the plan formulation process must be implementable. That is, the selected plan must be technically and economically feasible; socially, environmentally, and culturally acceptable; and capable of being carried out with a local sponsor.

In addition, although they are not constraints, the Executive Orders 11988 - Floodplain Management, and 11990 - Protection of Wetlands, and the Executive Memorandum on Prime and Unique Farmland should be considered as much as possible in plan development.

IDENTIFICATION AND DEVELOPMENT OF ALTERNATIVE PLANS

The most urgent water resource need of the basin is reduction of flood damage. The flooding problems occur throughout the county but the principal urban damage center is Portage. No other critical water resource need has been identified. Therefore, this appendix concentrates on all possible alternative plans to meet the flood damage reduction need of the study area.

Twenty-two alternatives were initially identified in the August 1977 Plan of Study. Each alternative was then considered in detail in the stage 2 portion of the study. The information is summarized in the following paragraphs under each alternative heading.

ALTERNATIVES CONSIDERED

The alternatives considered in this study include the following:

- No Action
- Improvement to Portage Levees (including a ring levee)

- Improvement to Portage and Lewiston Levees
- Improvement to Caledonia Levees
- Improvement to All Levees
- Outlet in Caledonia Levee
- Channel Modifications (including clearing and dredging)
- Diversion Channel to Baraboo River
- Diversion Channel to Long Lake
- Diversion Channel to Big Slough
- Reservoirs (including increasing storage at existing reservoirs and new reservoirs)
- Nonstructural Measures (including closures, raising structures, small walls, rearranging property, evacuation, floodplain regulation, floodplain insurance, and flood forecasting)

DESCRIPTION OF ALTERNATIVES

The description of alternatives includes not only a discussion of the action but also a **limited assessment of the economic, biological, cultural, social, and recreational impacts as presented in the January 1981 stage 2 document.**

No Action Alternative

With the no action alternative, no new flood control measures would be implemented and present conditions would prevail. Under these conditions, widespread flooding behind the Portage, Caledonia, and Lewiston levees would occur with the 1-percent chance flood of 85,000 cfs. The standard project flood of 145,000 cfs would result in deeper and more extensive flooding. The floodplain for the former conditions, assuming the levees are breached, is shown on the figure on page A-17.

The primary urban area flooded would be the southeastern portion (Ward 1) in Portage. This is the area bounded by the canal, the levee, and the eastern city limits. For the 1-percent chance flood and the

standard project flood, more than 300 residences would have flooding above the first-floor elevation. About 70 commercial and industrial businesses would also be damaged by either flood. Within this area, depths of flooding would be 10 feet or more for either the 1-percent chance or standard project flood. U.S. Highway 51 in Portage would be inundated for about 2 miles for both the 1-percent chance flood and the standard project flood. To a much lesser extent, flooding would also occur in the northwest and in the south central portion of Portage along Edgewater, Conant, Summit, and Carroll Streets.

In Lewiston Township about 10,000 acres and 20 structures would be flooded by the 1-percent chance flood. This area is primarily wetland and floodplain forest; one-fourth to one-third is agricultural land. About 1 mile of U.S. Highway 16 would be flooded. With the standard project flood, a few thousand additional acres, equally divided between farmland and forest, would be flooded.

On the same side of the Wisconsin River but downstream of Portage, about 5,000 acres and 10 structures in Pacific Township would be inundated by the 1-percent chance flood. Almost all of this area is wetland; however, about 1 mile of U.S. Highway 51 and the Chicago, Milwaukee, St. Paul and Pacific Railroad would also be flooded. About the same area would be flooded by the standard project flood.

Along the opposite bank of the river, about 17,000 acres of Caledonia Township and a small portion of Fairfield Township would be flooded by the 1-percent chance flood. Most of this land is wetland and floodplain forest; about one-third is agricultural land. About 50 structures in the area behind the levees would be affected. The 200 seasonal cottages and trailers in Blackhawk Park (downstream of the levees) would also be affected. Most of these structures, however, are elevated several feet off the ground to reduce flood damages. One to two miles of State Highways 33 and 78 would be inundated. Only slightly more area in these townships would be flooded by the standard project flood.

With this extensive floodplain area, floodplain regulation and flood insurance will remain an important part of a no action alternative. Floodplain regulation, consisting primarily of regulating new development in the existing floodplain areas, will help reduce future flood damages. On the other hand, flood insurance will provide affected individuals some economic protection by reimbursing property owners for those losses sustained from flooding. However, limited participation in the flood insurance program is expected.

The existing conditions biological impacts are assumed to remain constant or proceed in the same direction as at present. The Wisconsin Department of Natural Resources would continue to purchase private lands for public hunting areas. Some residential development would continue in the Long Lake area. There would be occasional periods of flooding, most often downstream of the Caledonia levee where the Baraboo River and Long Lake backflood. These occurrences would not cause extensive or long lasting impacts on the natural environment.

With a 1-percent chance flood and a total levee failure situation, at least 16 known cultural sites would be inundated by floodwaters of the Wisconsin River. Two of these sites are listed on the National Register of Historic Places (the Fox-Wisconsin Portage and the Portage Canal). A number of other sites along the sand ridges are within or adjacent to the 100-year floodplain. All of these other sites could also be affected by flooding.

Study area residents in the floodplain of the Wisconsin and Fox Rivers would remain vulnerable to severe flooding and its associated negative impacts on their social and economic well-being. Many residents in the study area do not perceive flooding as a threat because of their confidence in the existing levee system. Also, any damages now occurring to recreation resources would continue.

The existing levee system would remain and continue to be maintained by the Wisconsin Department of Natural Resources. Regular maintenance is needed to partially reduce the breaching potential of the levees. The Portage Canal historic lock gates will remain subject to potential failure in the event of a flood. As a result, the existing flood forecast, warning, and temporary evacuation plan would continue to be in effect for the county. In general, this plan is complete and involves maintenance, surveillance, and flood alert/emergency requirements.

Improvement of Portage Levee

The existing levee located within and downstream of the city of Portage would be strengthened, raised, widened, and extended. The total levee length would be about 3 miles. Flood protection would be provided in three areas of Portage, including the area near Summit and Carroll Streets (Ward 8), the area near Pauquette Park (including that between the Portage Canal and Ontario Street), and the area downstream of Ontario Street to County Road G. For 1-percent chance flood protection from the Wisconsin River, the existing levee would have to be raised between 1 and 6 feet. As part of this alternative, interior drainage would be provided where necessary. The general location of this alternative is shown on the following figure.

IMPROVEMENT of PORTAGE LEVEE

Damages to the city from various floods would be prevented. However, standard project flood protection is not possible with this alternative because the Wisconsin River overflow problem upstream of Portage causes backwater flooding on the Fox River in the Ward 1 vicinity. At the 1-percent chance flood level, this is not a problem. A summary of benefits and costs for the 1-percent chance flood level of protection is shown below.

Benefits and costs - improvement of Portage levee

Item	1-percent chance flood design protection
First cost	$2,866,000
Operation and maintenance	9,000
Average annual costs	221,000
Average annual benefits	852,000
Benefit-cost ratio	3.9

Modifying the Portage levee would adversely affect some riparian hardwood forest depending upon the alignment of the levee downstream of Portage.

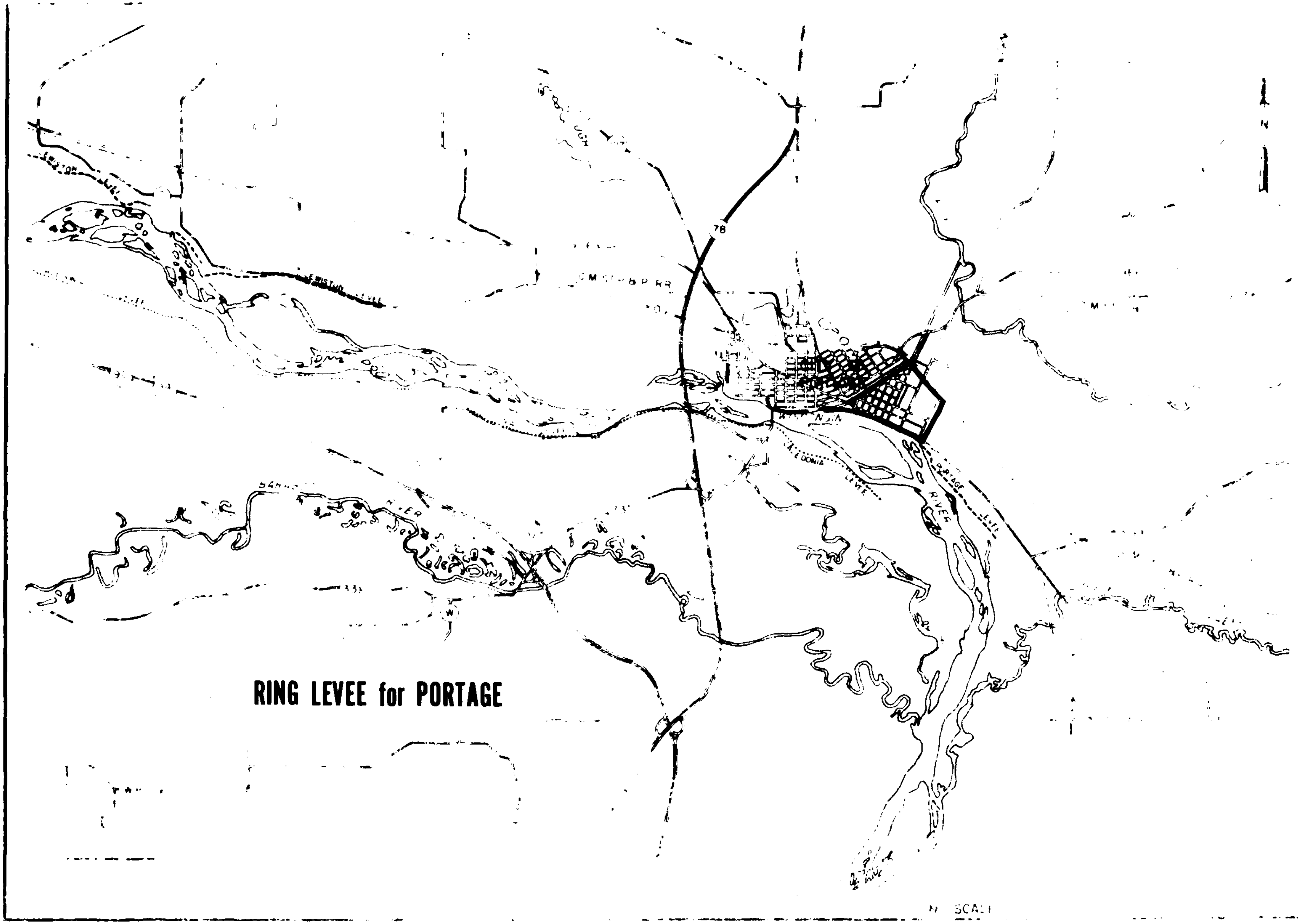
This alternative would have an impact on the Portage Canal which is listed on the National Register of Historic Places. Impacts to other cultural resources within the floodplain would be minimal since the existing leveed area has already been affected by construction.

The social well-being would improve because adverse impacts that accompany flooding would be reduced or prevented. These impacts include damage to and loss of personal property; loss of personal disposable income because of uncompensated losses, repayment of long-term reconstruction loans, or lost job revenues; loss of community facilities; drains on existing community services; disruptions in emergency services; and a reduction of the community tax base (which may affect the quality of the existing service structure).

Minimal disruption would occur to the current recreation uses in the area because the new construction would allow trails and other amenities to be incorporated into the levees.

Ring Levee for Portage

As displayed on the following figure, the ring levee alternative for Portage would consist of three main components: (1) a ring levee around the Ward 1 area in the southeast portion of the city, (2) a levee in the Pauquette Park and Edgewater Street areas, and (3) a road raise in the Summit Street area. The latter two components would be similar to those described in the improvement of the Portage levee alternative.


78
PORTAGE LEVEE
RIVER
CALEDONIA LEVEE
RING LEVEE for PORTAGE

Construction of the ring levee for Ward 1 would require upgrading the existing Portage levee between the Portage Lock and Ontario Street and developing a new levee from Ontario Street northeast to the Chicago, Milwaukee, St. Paul, and Pacific Railroad tracks and then northwest across the canal to high ground. Total levee length in this area is 11,800 feet. One option would be to incorporate the area north of the railroad tracks into the ring levee concept. Total length of that option would be 14,400 feet. With either option, 2 canal closures and 3 to 5 road closures would be necessary. Also, interior drainage facilities would be used as needed. Levee heights would be about 13 feet in the unleveed area and the levee widths would require acquisition of several residences near Ontario Street and the railroad.

An advantage of this alternative is the potential for providing flood protection from both the Wisconsin and Fox Rivers up to the standard project flood level. This alternative would afford flood protection to the most densely developed portion of the floodplain. A summary of the benefits and costs is shown below.

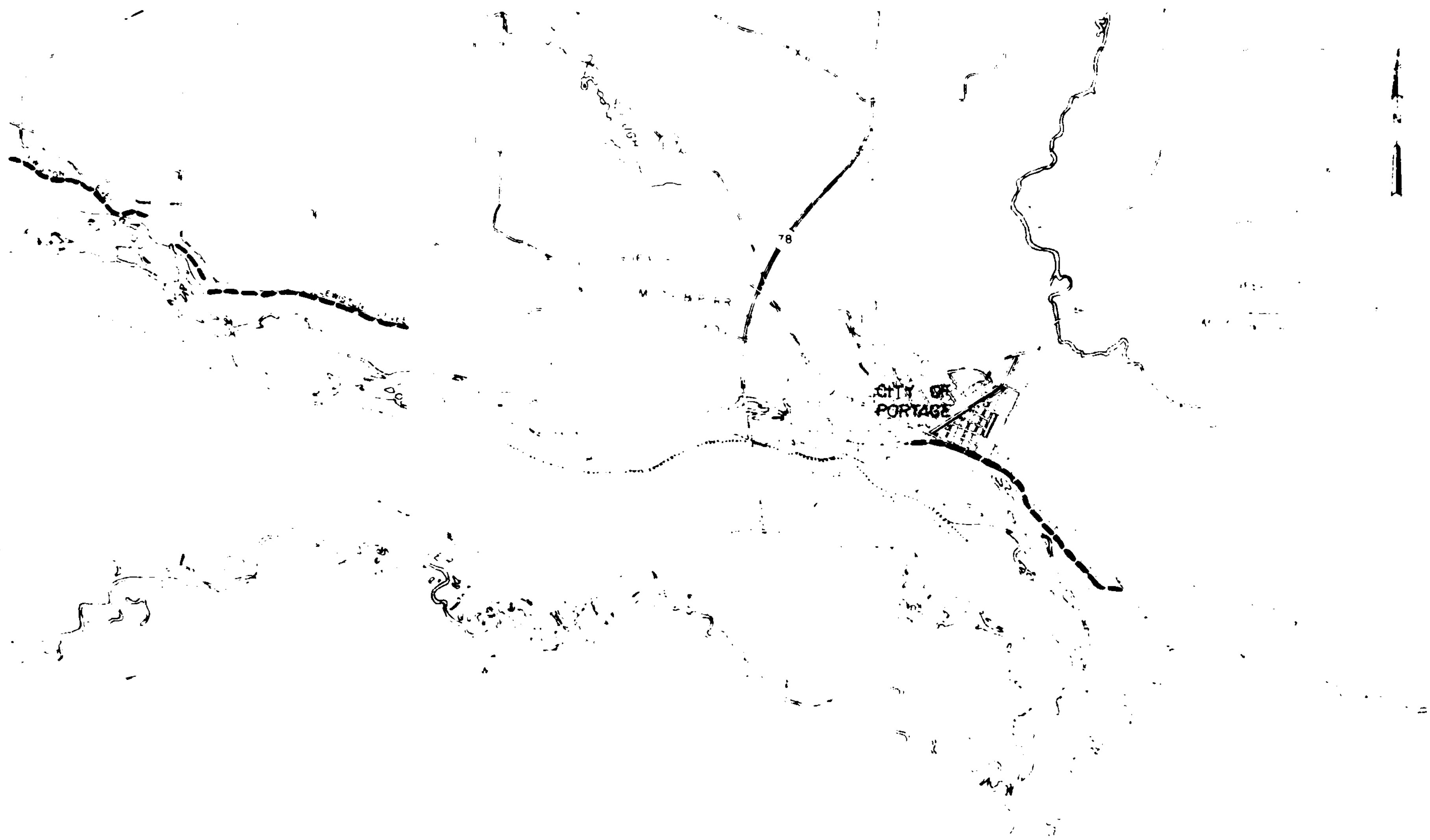
Benefits and costs - ring levee for Portage

Item	Design protection	
	1-percent chance flood	Standard project flood
First cost	$12,000,000	$13,000,000
Operation and maintenance	50,000	55,000
Average annual costs	936,000	1,015,000
Average annual benefits	900,000	950,000
Benefit-cost ratio	0.96	0.94

Socially, this alternative is not favored because it would disrupt the local cohesiveness. Additionally, the cultural effects would be significant because two crossings of the canal would be required and the Wauona Trail, also a national historic landmark, would be affected.

Improvement of Portage and Lewiston Levees

The existing Portage levee would be strengthened, widened, and extended; a new levee would be constructed near Pauquette Park; the existing road would be raised in the Summit Street area; and the levee in Lewiston Township would be upgraded to prevent floodwaters from overflowing U.S. Highway 16 and into the Fox River basin. The length of the Portage levee would be the same as in the previous alternative - 15,700 feet. Total length of the levees for this alternative is 42,900 feet or 8.1 miles. Interior drainage would be provided for the city of Portage as needed. The location of this alternative is shown on the following figure.



IMPROVEMENT of LEFT SIDE

Required levee heights for protection up to the 1-percent chance flood would be a maximum of 7 feet for Lewiston and 10 feet for Portage; for standard project flood protection, levee heights would be 10 feet for Lewiston and 12 feet for Portage.

Modification of the Portage and Lewiston levees would adversely affect the existing riparian hardwood forest. The height and frequency of flooding would be increased for Caledonia Township and areas downstream of the levees and, to a lesser extent, for areas upstream of the levees. For this area, flowage easements (not included in this estimate) would be acquired from landowners to compensate for increased flooding induced by the project, or nonstructural damage reduction measures such as flood proofing could be incorporated. A summary of benefits and costs is shown below.

Benefits and costs - improvement of Portage and Lewiston levees

Item	Design protection	
	1-percent chance flood	Standard project flood
First cost	$4,945,000	$5,671,000
Operation and maintenance	23,000	27,000
Average annual costs	388,000	445,000
Average annual benefits	882,000	947,000
Benefit-cost ratio	2.3	2.1
Benefit-cost ratio for Lewiston levee alone	0.2	0.2

This alternative would have the same cultural impacts as those listed for the Portage levee, plus a potential impact to a recorded archeological site along the Lewiston levee. The exact location of this site is unknown.

Another potential direct impact of upgrading the Portage and Lewiston levee system may be an increase in the flood elevation at the Aldo Leopold Shack, a National Register property along the south bank of the Wisconsin River.

Socially, this alternative would have the same impacts as the Portage levee improvement. Prevention of flood damage with this alternative would also benefit the social well-being of Lewiston Township residents and, to a much lesser extent, residents of communities along the Fox River.

Raising the existing levees would probably cause minimal disruption of current recreation uses. The new construction would allow trails and other amenities to be incorporated into the levees.

Improvement of the Caledonia Levee

This levee improvement would involve upgrading the existing levee on the south bank of the Wisconsin River between the Pine Island Hunting Area and the downstream end of Portage. Total length of the levee would be about 9.2 miles. The location of this alternative is shown on the following figure.

IMPROVEMENT of CALEDONIA LEVEE ONLY

The benefits and costs for this alternative are shown below.

Benefits and costs - improvement of Caledonia levee

Item	Design protection	
	1-percent chance flood	Standard project flood
First cost	$7,300,000	$7,548,000
Operation and maintenance	25,000	27,000
Average annual costs	564,000	585,000
Average annual benefits	66,000	71,000
Benefit-cost ratio	0.1	0.1

Approximately 120 acres of riparian hardwood forest would be adversely affected. Also, four known prehistoric archeological sites could be potentially affected; however, these sites are located on sand ridges above the existing 100-year floodplain.

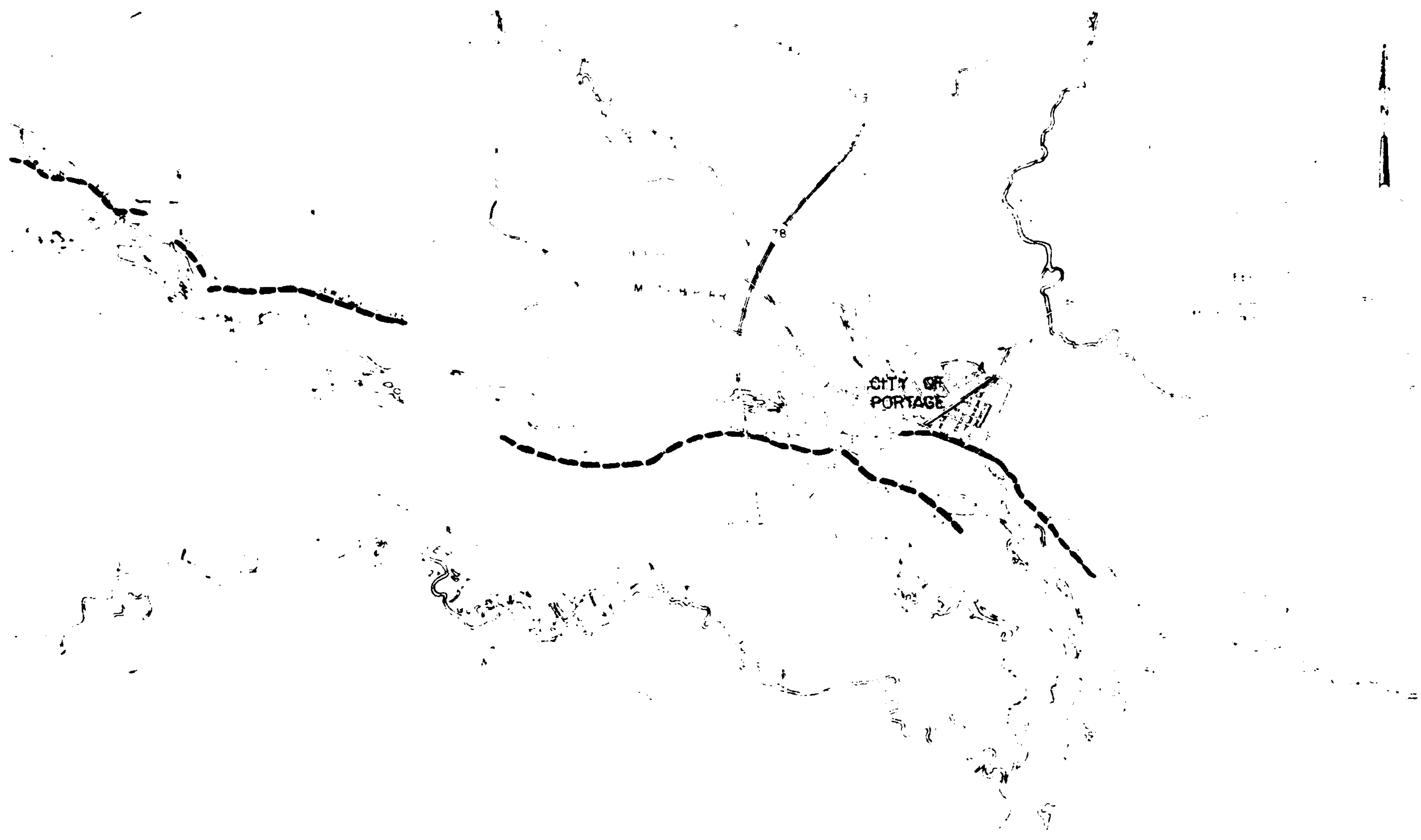
The height and frequency of flooding downstream and to a lesser extent upstream would be increased with this alternative. Flowage easements or some form of compensation would be provided landowners in those areas.

Socially, this alternative would benefit the residents in Caledonia Township; however, the social impacts in other areas would be negative. The recreation impacts would be similar to those with the other levee alternatives.

Improvement of All Levees

The existing Portage, Lewiston, and Caledonia levees would be strengthened, widened, extended, and raised. New levees would be necessary in Portage as discussed in the Portage levee alternative. The length of the Portage and Lewiston levees would be 3.0 and 5.1 miles, respectively. Adding in the Caledonia levee would make the total length

for all levees 17.3 miles. Required levee heights for 1-percent chance flood and standard project flood protection are the same as those presented in the individual levee improvements. Interior drainage would be provided only for the city of Portage. The location of this alternative is shown on the following figure.



IMPROVEMENT of ALL LEVEES

This alternative would increase the flood potential of the Blackhawk Park residential area and areas farther downstream. It could also have a very slight adverse effect on areas upstream of the levees. Flowage easements would be paid to landowners in these areas to compensate for increased flooding, or nonstructural measures such as flood proofing could be used. A summary of benefits and costs is shown below.

Benefits and costs - improvement of all levees

Item	Design protection: 1-percent chance flood	Design protection: Standard project flood
First cost	$11,715,000	$22,564,000
Operation and maintenance	50,000	59,000
Average annual costs	915,000	1,724,000
Average annual benefits	948,000	1,018,000
Benefit-cost ratio	1.04	0.6

Modification of existing levees would adversely affect various amounts of riparian hardwood forest in each area.

This alternative would combine the cultural impacts from the Portage and Lewiston levees with those from the Caledonia levee. Four known prehistoric archeological sites could potentially be affected by upgrading the Caledonia levee. All of these sites are located along the right descending bank of the Wisconsin River on sand ridges above the 100-year floodplain. The potential for adverse impacts on additional sites that may exist along the Lewiston levee is even greater. This alternative would have the same effect on the Aldo Leopold site as the combined Portage and Lewiston levee alternative.

Prevention of flood damages would benefit the social well-being of residents in Portage and in Lewiston and Caledonia Townships. However, the associated social impacts in downstream areas would be worse.

Raising the existing levee would also probably cause minimal disruption of current recreation uses. The new construction would allow trails and other amenities to be incorporated into the levees. It is assumed the overall impacts would be beneficial.

Caledonia Outlet

This alternative would provide an opening in the Caledonia levee to reduce flood flows to the Portage and Lewiston areas. The outlet would be 5,000 feet long, cutting 7 feet below the crest of the existing levee. The outlet would be located in the Pine Island Hunting Area as shown on the following figure. The existing Caledonia levee would have to be strengthened to Corps standards (but not raised) to prevent overflows from reentering the Wisconsin River near Portage. The 6,000 acres of the hunting area would be used for storage of Wisconsin River overflows.

CALEDONIA OUTLET

To provide protection up to the 1-percent chance and standard project floods, 25,000 cfs and 85,000 cfs, respectively, would have to flow through the outlet. The hydraulic analysis (HEC-2) indicates that for the 1-percent chance flood only 4,000 cfs of the required 25,000 cfs would flow in the overbank area. Because of its low conveyance, the Pine Island Hunting Area would act like a lateral reservoir. However, this area does not have nearly enough storage to contain the approximately 250,000 acre-feet of water required to provide protection for the 1-percent chance flood.

With this alternative it would not be hydraulically feasible to provide protection from larger floods. A summary of benefits and costs is shown below.

Benefits and costs - Caledonia outlet

Item	Amount
First cost	$3,623,000
Operation and maintenance	5,000
Average annual costs	273,000
Average annual benefits	253,000
Benefit-cost ratio	0.92

The principal biological impact of this alternative would be an increase in the rate of sedimentation within the Pine Island Hunting Area. Under present conditions, a significant rise in the level of the Wisconsin River causes backflooding in the Long Lake and Baraboo River drainages, which include the hunting area. The proposed outlet would probably cause flooding in the same area, but the entering water would carry a significantly higher sediment load. The sedimentation that would occur as the entering river water lost its velocity would be significantly greater than that resulting from backflooding.

No known cultural resources would be affected because the relatively low area of the floodplain which would receive flood flows does not have a high potential for cultural resources. Construction of levees around the wetlands within the floodplain also has a low potential for impacts on cultural resources.

This alternative would benefit the social well-being as discussed under the Portage levee alternative, but to a lesser degree. Relocation of Caledonia residents and businesses may be required and would likely encounter significant opposition, resulting in an adverse effect on social well-being.

The Wisconsin Department of Transportation recognizes Interstate 90-94 as a vital transportation corridor and a considerable public investment. Therefore, the department is opposed to degrading any portion of the Caledonia levee which would jeopardize Interstate 90-94. In addition, the department believes this alternative would adversely affect State Trunk Highways 78 and 33. Delivery of emergency services could be jeopardized if these transportation routes were affected.

The deterioration of habitat in the Pine Island Hunting Area would also cause a corresponding loss in recreation opportunities.

Channel Modification - Dredging

Two channel dredging plans were considered for the same general channel area (see the following figure). The first calls for dredging a trapezoidal channel having a bottom width of 1,500 feet and a slope of 2.7 vertical feet per 10,000 feet of channel. The dredged reach would be about 11 miles between Pine Island and the mouth of the Baraboo River. About 1,900,000 cubic yards of channel material would be dredged and placed outside the floodplain. The second dredging plan would be similar to the first except the bottom width would be only 1,000 feet. With this version, about 650,000 cubic yards of channel material would be dredged and placed outside the floodplain.

CHANNEL MODIFICATION

The first plan would lower the 1-percent chance flood by 4.9 feet, or 2 feet below the level needed to prevent overflow. Therefore, the Portage area and the Fox River basin would be free of damage from floods up to this magnitude. The standard project flood would be lowered by 6.9 feet compared to the 9.5 feet needed to prevent overflow. Standard project flood damages would therefore be reduced but not prevented.

In the second plan, the 1-percent chance flood would be lowered 3.5 feet, or 0.6 foot below the overflow conditions. However, this freeboard would not meet design criteria and could not be assumed to provide full protection. The standard project flood would be lowered 5.7 feet compared to the 9.5 feet required to prevent overflow. Damages would therefore be reduced but not prevented.

The flooding potential to areas downstream of the dredged channel would be increased somewhat by either plan. Because of the large quantity of shifting sands in the channel, extensive maintenance dredging would also be required annually for either plan.

A summary of benefits and costs is shown below.

Benefits and costs - channel modification - dredging

Item	Bottom width at dredged channel 1,500 feet	Bottom width at dredged channel 1,000 feet
First cost	$17,556,000	$5,858,000
Operation and maintenance	878,000	293,000
Average annual costs	2,174,000	725,000
Average annual benefits	711,000	569,000
Benefit-cost ratio	0.3	0.8

The proposed channel modification would drastically alter the existing river habitat. The extensive deepening and widening of the main channel would destroy large quantities of fish cover, disrupt the aquatic flood chain, and remove all or substantial portions of existing islands which serve as habitat for upland animals and waterfowl. In addition, the frequent disturbance from maintenance dredging would also cause significant turbidity and related problems downstream.

The potential for impacts on cultural resource sites during the dredging process is not great; however, the disposal of the dredged material at a location out of the Wisconsin River floodplain has a very great potential for impacts on cultural resources.

The most significant social impacts associated with channel modification would result from construction activities and disposal of dredged, snagged and cleared materials.

Construction activities are likely to inconvenience river users and persons whose residences are located along access routes to the river. These activities would also disrupt the natural setting of the river for a period of time, resulting in a loss in aesthetic values. During this time, the value of the river-use experience could be expected to decrease.

Channel Modification - Clearing

To improve the capacity of the Wisconsin River, extensive clearing of trees and brush would be accomplished in the channel and overbank areas in the 11-mile reach between Pine Island and the mouth of the Baraboo River (see the figure on page A-46). The width of the clearing would be about 2,500 feet. Under this alternative the overbank areas cleared of trees and brush could carry about twice as much flow as under existing conditions but the capacity of the main channel would be increased only slightly.

This alternative would lower the 1-percent chance flood by 1.7 feet compared to the 2.9 feet reo ired to prevent damages; the standard project flood would be lowered by 2.0 feet compared to the 9.5 feet needed. Therefore, overflows to the study area would be decreased, but not nearly enough to prevent major damages.

A summary of benefits and costs is shown below.

Benefits and costs - channel modification - clearing

Item	Amount
First cost	$12,750,000
Operation and maintenance	40,000
Average annual costs	981,000
Average annual benefits	569,000
Benefit-cost ratio	0.6

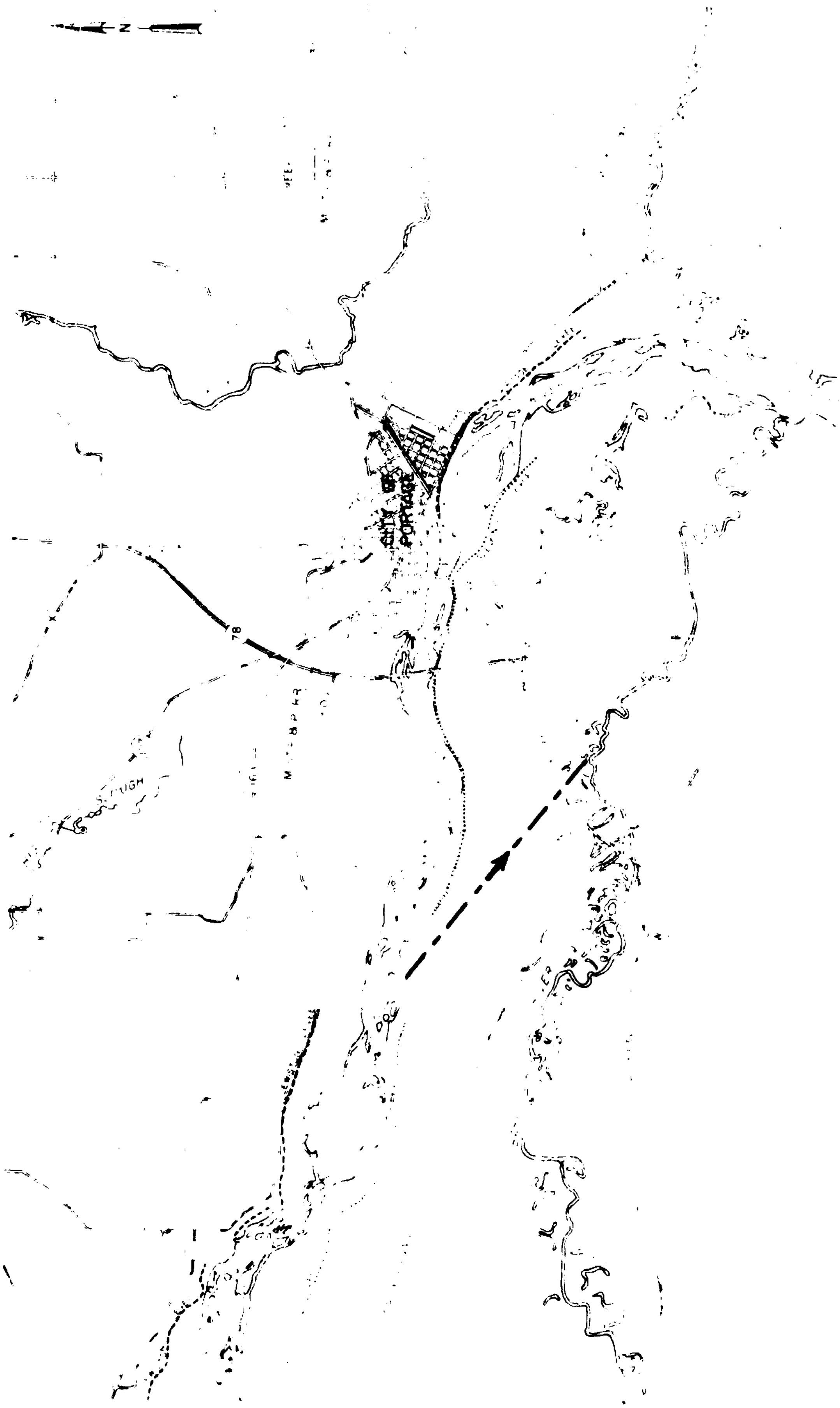
The clearing of all vegetation between the levees would result in a substantial loss of valuable riparian habitat. A smaller amount of aquatic habitat would be lost when the undermined trees and shrubs were removed.

This alternative would affect the same cultural/archeological site as the Lewiston levee alternative. The potential for impacts on cultural resources from clearing the floodplain forest is not high; however, unknown cultural resources in these areas could be disturbed.

The social impacts of this alternative would be similar to those for channel dredging, but less severe. Also, there would be adverse impacts on existing recreation resources.

Channel Diversion to the Baraboo River

A channel to divert flood flows from the Wisconsin River through Caledonia Township to the Baraboo River would be built as shown in the following figure. Most of the 16,000 feet of channel would be in the Pine Island Hunting Area. The State Highway 78 bridge over the Baraboo River would have to be raised and a new bridge would be built for State Highway 33.



DIVERSION CHANNEL - BARABOO RIVER

To provide protection up to the 1-percent chance flood, the diversion would be designed to carry 25,000 cfs in a channel 20 feet deep and 620 feet wide at its top. For standard project flood protection, the diversion would be designed to carry 85,000 cfs in a channel 20 feet deep and 1,860 feet wide at its top.

Benefits and costs - channel diversion to the Baraboo River

Item	Design protection: 1-percent chance flood	Design protection: Standard project flood
First cost	$78,500,000	$210,269,000
Operation and maintenance	40,000	60,000
Average annual costs	5,834,000	15,580,000
Average annual benefits	948,000	1,018,000
Benefit-cost ratio	0.2	0.1

The route of the proposed diversion would pass through the Pine Island Hunting Area and follow existing streambeds and low areas. Some wetland areas would be destroyed directly and others indirectly from lowering of the area's water table. In addition, the construction and maintenance of a structure the size of the proposed channel would significantly reduce the overall value of the area to wildlife.

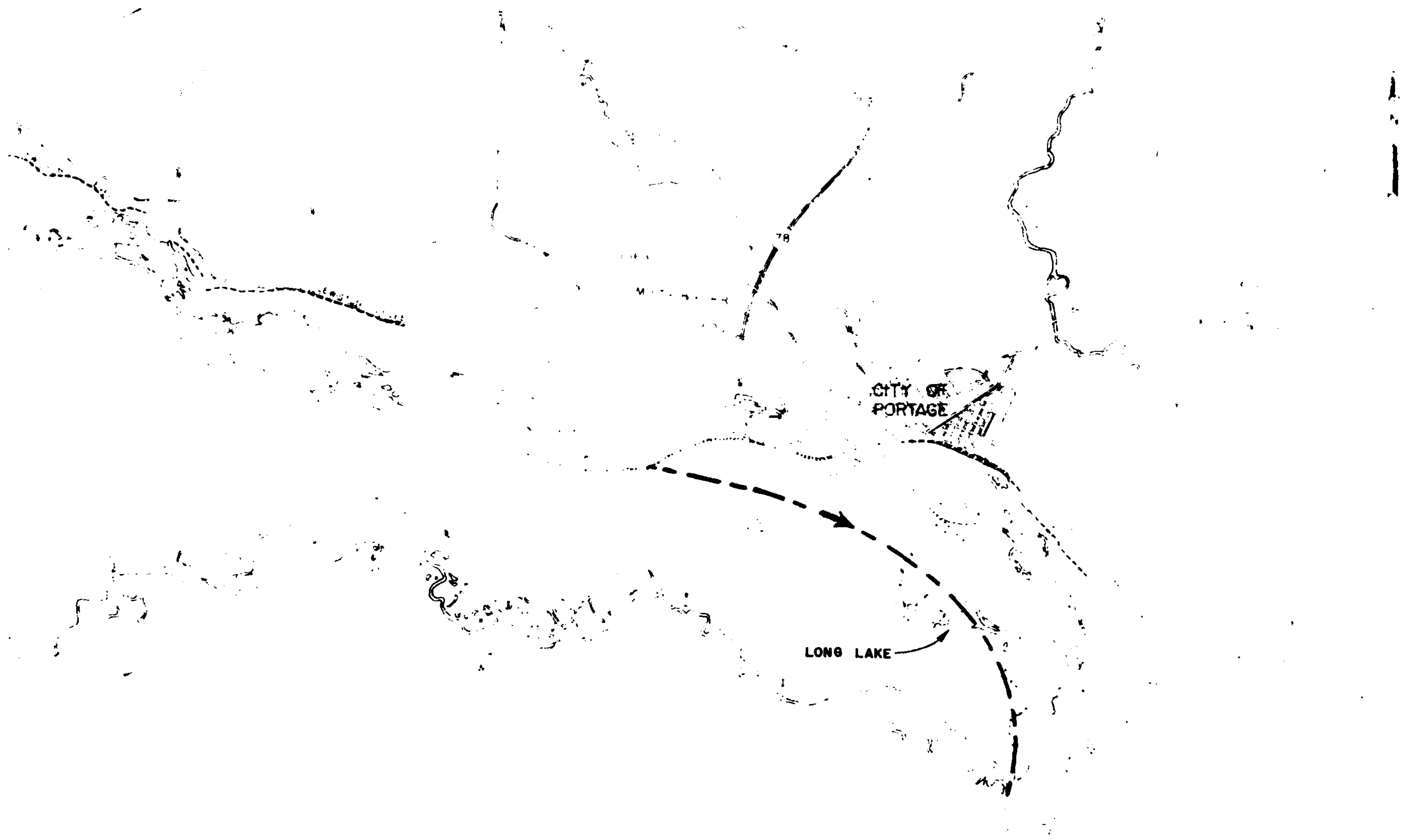
This alternative would affect one prehistoric site located on a ridge along the Wisconsin River. The general impacts of this alternative are the same as those for the Long Lake alternative with upland disposal having the greatest potential for disturbing cultural resources.

Reduction of flood damages in Portage and Lewiston Township would benefit social well-being by reducing the adverse social impacts that accompany flooding. However, flooding of the Baraboo River would worsen, inflicting more severe flood damages on property and associated economic costs on property owners in that area. Depending on the diversion alignment and specific effects on downstream flooding conditions,

a number residences or buildings may need to be acquired. In addition, because this diversion cuts randomly across land sections, landowners may experience interference with and/or physical and economic hardships in maintaining existing land uses. Property values may decrease, negatively affecting landowners. Therefore, this alternative would be controversial and disruptive to community cohesion.

Channel Diversion to Long Lake

A channel to divert flood flows from the Wisconsin River through Caledonia Township and back into the Wisconsin River via Long Lake would be built as shown on the following figure. The channel would be 20,000 feet long and about 16 feet deep. Bridge raises would be needed for State Highways 33 and 78.



DIVERSION CHANNEL - LONG LAKE

To provide protection up to the 1-percent chance flood, the diversion would be designed to carry 25,000 cfs in a channel 380 feet wide at its top. For standard project flood protection, the diversion would be designed to carry 85,000 cfs in a channel 2,950 feet wide at its top.

Damages from floods up to the design flood would be prevented in the Portage area and the Fox River basin. A summary of benefits and costs is shown below.

Benefits and costs - channel diversion to Long Lake

Item	Design protection: 1-percent chance flood	Design protection: Standard project flood
First cost	$59,257,000	$82,693,000
Operation and maintenance	50,000	70,000
Average annual costs	4,423,000	6,174,000
Average annual benefits	948,000	1,018,000
Benefit-cost ratio	0.21	0.16

The Long Lake diversion channel would pass through the Pine Island Hunting Area. This channel's impacts would be similar to those of the Baraboo River diversion. Any work to modify the existing channel in Long Lake would probably have negative effects on the lake and the surrounding wetlands. The fauna which depend on this habitat would be affected correspondingly.

This alternative could disturb a known archeological site which has already been affected to an undetermined extent by the construction of State Highway 78. Because construction of the channel would follow low, marshy areas, it would have only a moderate potential for disturbing unknown cultural resources on the western end of the diversion. The potential may be slightly higher on the eastern end, since it follows Long Lake, part of the old Wisconsin River channel.

The major impacts resulting from this alternative would involve disposal of excavated material out of the Wisconsin River floodplain. Upland disposal could have an adverse impact on cultural resources outside the project area.

Social impacts similar to those discussed for the diversion to the Baraboo River would be expected. Because this diversion traverses a greater distance and involves more land and homeowners, these impacts would be expected to be more extensive. In addition, the present aesthetic and recreation values of Long Lake would be destroyed by channelization. Flooding conditions would worsen on the Wisconsin River, downstream of Long Lake, possibly increasing the negative social impacts on downstream residents and communities.

Channel Diversion to Big Slough

A channel to divert flood flows from the Wisconsin River through Lewiston Township to Big Slough in the Fox River basin would be built as shown on the following figure. The channel would be 20,000 feet long. Bridges would be needed for U.S. Highway 16, a railroad, and a county road.

DIVERSION CHANNEL - BIG SLOUGH

To provide protection up to the 1-percent chance flood, the diversion would be designed to carry 25,000 cfs in a channel 16.5 feet deep and 365 feet wide at its top. For standard project flood protection, the diversion would be designed to carry 85,000 cfs in a channel 24.5 feet deep and 1,060 feet wide at its top.

Damages from floods up to the design flood would be prevented in the Portage and Caledonia areas. However, widespread flooding would occur in Lewiston Township because the Big Slough could not handle the diverted flows. A summary of benefits and costs is shown below.

Benefits and costs - channel diversion to Big Slough

Item	Design protection: 1-percent chance flood	Design protection: Standard project flood
First cost	$126,400,000	$355,396,000
Operation and maintenance	40,000	60,000
Average annual costs	9,370,000	26,292,000
Average annual benefits	733,000	786,000
Benefit-cost ratio	0.08	0.03

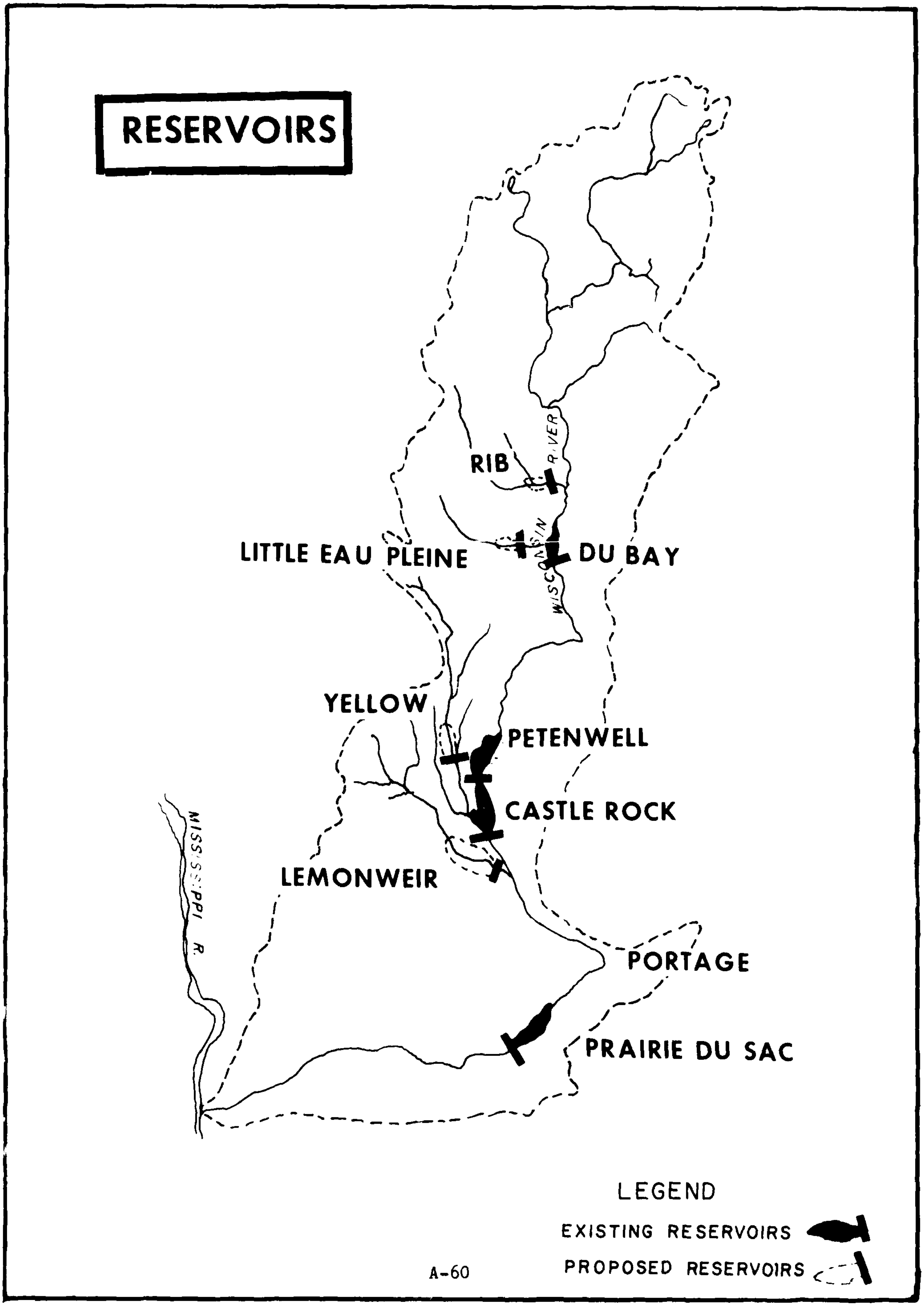
The Fox River diversion channel would have greater impacts than the other two proposed diversion plans. It would result in modification or destruction of larger amounts of natural habitat and resident fauna. Particularly significant would be a sedimentation problem which would probably occur at the northern pike spawning area and impacts to additional recreation resources in the Big Slough region.

No known cultural resources would be affected, and the general impacts would be the same as those for the Long Lake diversion.

Social impacts would be similar to those discussed for the diversion to the Baraboo River, although this diversion would traverse a much greater distance and more landowners would be affected. Flood damage and associated negative social impacts would be worse for communities and residents along the Fox River.

Increasing Flood Storage at Existing Dams

Three plans were considered for reducing flows at Portage by increasing flood storage at the existing dams. The following figure shows the general location of the existing reservoirs.


RESERVOIRS
RIB
WISCONSIN RIVER
LITTLE EAU PLEINE
DU BAY
YELLOW
PETENWELL
CASTLE ROCK
MISSISSIPPI R.
LEMONWEIR
PORTAGE
PRAIRIE DU SAC
LEGEND
EXISTING RESERVOIRS
PROPOSED RESERVOIRS

Lower operating pools. - The first plan would lower the operating pools of the Castle Rock, Petenwell, and Du Bay hydropower dams, the closest dams to Portage (45, 48, and 134 miles upstream, respectively) that have significant storage. The U.S. Geological Survey streamflow model indicates that the existing 21 storage reservoirs and 3 large hydropower dams reduce the 1-percent chance flood by 10,000 cfs. This reduction is due largely to winter drawdown of the reservoirs in anticipation of spring floods. Flood flows at Portage would have to be reduced an additional 25,000 cfs and 85,000 cfs to provide protection up to the 1-percent chance and standard project floods, respectively.

The Castle Rock, Petenwell, and Du Bay Dams are normally drawn down 4 to 5 feet to store spring floods. Spring floods occur with about the same frequency as summer and fall floods. Lowering the operating pools 5 feet during the summer and fall as well as in spring would not protect Portage from the 1-percent chance flood. In addition, a permanent 5-foot lowering would reduce power generating capacity by 10 to 15 percent at each dam.

Raise existing dams. - The second plan to increase flood control storage would be to raise the heights of the Castle Rock, Petenwell, and Du Bay Dams. Again, based on the results of the Wisconsin River streamflow model and review of 30 years of reservoir operations, it can be reasonably concluded that additional storage at the existing dams would not reduce flows at Portage by the 25,000 cfs needed to control the 1-percent chance flood. Increasing the height of the existing dams by 5 feet would require raising 15 miles of levees, installing 45 large tainter or flood gates, and reconstructing powerhouse walls to make them waterproof.

Modify operation of Prairie du Sac Dam. - The third plan considered was modifying the operation of the Prairie du Sac Dam, which is about 25 miles downstream of Portage. Lake Wisconsin, about 12 miles long, is formed by the dam. During both normal and flood conditions, the

operation policy is to maintain a constant elevation of 774 feet above mean sea level at the gated spillways. The only exception is when the lake level is drawn down in anticipation of downstream flood conditions.

The gated spillway capacity of the Prairie du Sac Dam is very large (91,000 cfs). Hydraulic studies indicate that floods up to and including the standard project flood could be passed through the gates while maintaining a pool elevation of 774 feet at the dam. According to historical high-water marks designated by local citizens, the record flood in 1938 and other large floods in 1960 and 1973 caused a rise of less than 1 foot in Lake Wisconsin.

Past operation of the Prairie du Sac Dam, therefore, has not affected upstream flood conditions at Portage. Lowering Lake Wisconsin during floods also would not affect flood conditions at Portage because of the distance involved.

Increasing storage at existing dams would not protect Portage from large floods. Because the costs would be exceptionally high compared with the benefits, no economic analysis was done.

Lowering existing reservoirs would decrease the quality of aquatic habitat in those reservoirs and, at the same time, increase the potential for erosion on the newly exposed beaches. Impacts on cultural resources caused by lower operating levels would result from potential development of previously inundated resources. The condition of these resources would need to be evaluated. Although the impact of lowering the operating pools depends on the amount of change and the physical configuration of each reservoir, in general, this would have an overall adverse impact on recreation.

Raising the existing reservoirs would inundate a significant amount of terrestrial habitat and could inundate a number of historic and prehistoric resources along the existing shoreline. Raising existing reservoirs would also impact recreation resources and cause infrequent flooding of areas not now subject to flooding.

Social impacts of this alternative would result from acquisitions, changes in water and related land resource uses, influx of construction crews and their families, additional employment opportunities, and new demands on existing regional services and facilities.

New Reservoirs

Reducing floods at Portage by constructing upstream reservoirs was considered. See the figure on page A-60 for approximate locations. These reservoirs would need to reduce flood flows at Portage by 25,000 cfs and 85,000 cfs to provide protection up to the 1-percent chance and standard project floods, respectively.

In evaluating the upstream areas of the basin, little potential was found for new reservoirs on the Wisconsin River main stem. Also, the size of dam needed to control a drainage area of 8,000 square miles excludes it as a practical alternative. The only significant uncontrolled tributaries are the Lemonweir, Yellow, Little Eau Pleine, and Rib Rivers which are 33, 46, 123, and 151 miles, respectively, above Portage. Drainage areas of these tributaries vary from about 400 to 800 square miles, which is about 5 to 10 percent of the drainage area at Portage.

Because of their distance from Portage and relatively small drainage areas, new reservoirs would not provide protection from large floods, and the costs would be exceptionally high compared with the benefits. Therefore, no economic analysis was done.

Biological impacts from construction of new reservoirs would include inundation and loss of a significant amount of terrestrial habitat. The potential effect on the cultural resources would likewise be great since there are 38 and 133 known historic and prehistoric sites, respectively, in the four subbasin areas.

Social impacts would be similar to those discussed under "Increasing Flood Storage at Existing Dams." Although new reservoirs could provide additional lake-oriented recreation opportunities, they would also destroy the existing uses of the streams.

Nonstructural Measures

Nonstructural measures were considered as a means to reduce flood damages. These measures do not try to confine a river within its banks or to store or divert floodwaters. Rather, they emphasize ways of reducing damages to existing structures and implementing policies to restrict new developments in the floodprone areas.

Examples of nonstructural measures include:

- Installing closures on openings in structures
- Raising existing structures in-place
- Constructing small walls or levees around structures
- Rearranging or protecting damageable property within a structure
- Acquisition of structures in the floodplain
- Implementing floodplain regulations
- Providing flood insurance
- Implementing flood forecasting and warning systems and an evacuation plan

The first five measures were considered for the structures located within the primary floodprone area of Blackhawk Park (Caledonia Township) and Portage. The remaining three measures were considered for the floodplain area within the study boundaries. Each measure will be discussed in the following paragraphs.

Closures. - Watertight closures would be installed on openings such as doorways and windows and a sealant would be applied to walls to keep water out. Closures are not effective, however, if the exterior walls are water permeable as are wood, aluminum, or sheet metal sidings or older masonry structures with extensive cracking. Most of the structures in the study area floodplain would not be able to keep water out even with closures. Therefore, this alternative is not practical.

Raising existing structures. - Existing structures would be raised by jacks onto a higher foundation. Examples can be found in the Blackhawk Park area where many of the cottages are raised on blocks or wood pilings. Consideration was given to raising the remaining structures in the Blackhawk Park area and Portage an average of 3 or 5 feet (as needed). Because many of the buildings are more than 40 years old, this alternative would not be practical.

Small walls or levees. - Small walls or levees around individual structures were considered. In Portage there would not be sufficient room for small earth levees between buildings. Therefore, estimates were made for 3-foot or 5-foot (as needed) concrete walls around each of the structures in that area. For the Blackhawk Park area, small levees are possible but they are practical only for structures not presently raised.

Rearranging or protecting damageable property. - Damageable property within a structure can often be placed in a less damageable location or protected in-place. For example, furnaces, water heaters, and other utilities could be raised off the floor. Commercial and industrial finished products could be relocated to a higher elevation. This

alternative is particularly suitable for shallow flooding. However, in the study area, flooding would be 1 to 5 feet above ground for the 1-percent chance flood and would inundate most structures above the first floor. This alternative therefore would not be effective for large floods. Every property owner should, of course, locate damageable property to keep losses to a minimum.

Acquisition of structures in the floodplain - This alternative would remove the existing structures in the floodplain. One option would be to relocate the existing buildings outside the floodplain. Because many of the homes in Portage and Blackhawk Park are more than 40 years old, this option would not likely be practical. A second option is to purchase floodplain property in fee, demolish existing floodprone structures, and reuse the land for agriculture or other compatible floodplain uses.

Floodplain regulations. - Regulations on the development of floodplain land are currently being formulated for the study area by the Wisconsin Department of Natural Resources. Base-line hydrologic and hydraulic data for these regulations were provided by this study and the U.S. Geological Survey streamflow model.

Under State law, no development is permitted in the floodway (the area between the existing levee), and new developments in the flood fringe must be elevated 2 feet above the 1-percent chance flood.

Flood insurance. - The Federal Emergency Management Agency recently completed a flood insurance study (FIS) for Columbia County. The Wisconsin River and Fox River hydraulic and hydrologic data shown in the FIS are based on, and compatible with, hydraulic and hydrologic data developed for this study. The FIS study, which is scheduled for adoption by the county in 1983, will allow the county to convert from the emergency phase to the regular phase of the National Flood Insurance Program. Conversion to the regular phase increases the amount of

insurance available. For instance, in the emergency phase, coverage for a single-family residence, structure only, was limited to $35,000. In the regular phase, the same structure can be insured up to $185,000. The FIS presents floodplain zone data which will be used by insurance institutions to set the actual rates for properties in the various floodplain areas.

Flood forecast and warning and evacuation plan. - Because the Wisconsin River at Portage has a large drainage area (about 8,000 square miles), the river rises slowly over a period of days, giving sufficient warning. The National Weather Service forecasts flood elevations at Portage and several locations upstream. The Columbia County Office of Emergency Government has a comprehensive plan for levee maintenance and surveillance during high flows and an evacuation plan if a levee is breached.

ASSESSMENT AND EVALUATION OF ALTERNATIVES

The purpose of this evaluation is to identify alternatives that best satisfy the study objectives and are worthy of further consideration. The effectiveness, acceptability, completeness, and efficiency of each alternative are summarized in the following figure. The stage 2 documentation published in January 1981 further breaks down impacts on biological and social resources. All these data were important for determining the relative merits of each alternative compared with the no action alternative. The subsequent paragraphs discuss the results of the assessment process used to identify alternatives that were recommended for further consideration and screening in the stage 2 document.

Alternative analysis

Alternatives	Approximate effectiveness in reducing study area flood damages (percent)	Acceptable to both local/State interests	Completeness by itself(1)	Efficiency (cost effective)(2)
Levee Improvement				
Portage	75	Yes	Yes	Yes
Portage (ring levee)	80	No	Yes	Questionable
Portage & Lewiston	80	No	Yes	Yes(3)
Caledonia	10	No	No	No
All levees	85	Yes	Yes	Yes(3)
Caledonia Outlet	25	No	No	No
Channel Modification				
Snagging & clearing	60	No	No	No
Dredging	50	No	Yes	No
Channel Diversions				
Baraboo River	85	No	Yes	No
Long Lake	85	No	Yes	No
Big Slough	65	No	Yes	No
Reservoirs				
Raising existing	-	No	No	No
Lowering existing	-	No	No	No
New	-	No	No	No
Nonstructural				
Installing closure structures	-	No	No	-
Raising structures	35	No	No	-
Small walls	15	No	No	-
Rearranging damageable property	-	No	No	-
Acquiring structures	65	No	Yes	Questionable
Floodplain regulations	-	Yes	No	-
Flood insurance	-	Yes	No	-
Flood warning system	-	Yes	No	-
No Action	-	No	No	-

(1) Provides for at least 1-percent chance flood protection.
(2) Yes indicates positive net benefits; No indicates negative net benefits.
(3) In total, the alternative is economically feasible; however, one or more portions of the alternative are not incrementally justified.

Of all the levee alternatives, only improvement of the existing Portage levee system is cost effective because it would provide more benefits than costs. This is because most of the flood damages within the study area occur within the city of Portage. The Lewiston and Caledonia levees are not economically feasible by themselves and therefore are not worthy of further recommendation. For the same reason, a total levee system for all three areas and a combination Lewiston and Portage alternative lacks the necessary incremental economic justification. However, there is one exception that warrants additional consideration. A flood flow analysis of the Wisconsin River indicates that floods in excess of the 500-year level will overflow into the upper Fox River basin and possibly influence flood stages on the Fox River in the Ward 1 area of Portage. Therefore, a combination levee in Lewiston with improvement of the Portage levee alternative could prevent this overflow to the Fox River and provide Portage with a greater than 500-year level of flood protection. From this aspect, additional study is warranted for this alternative.

Similarly, a ring levee for the Ward 1 area of Portage would offer the same degree of protection from both the Wisconsin and Fox Rivers. However, the economic feasibility of the ring levee alternative is questionable. Also, significant effects to the national historic landmarks would occur in three locations, and the social well-being of the city would be disrupted by the required evacuation of several residential structures. From this aspect, the ring levee alternative should be considered only as a variation to the Portage and Lewiston levees.

An outlet in the Caledonia levee is not recommended for several reasons: damages from large floods would not be reduced, costs would be much greater than benefits, and impacts on biological and social resources would be severe.

Channel modification by clearing or dredging is not recommended because the costs would substantially exceed benefits and the impacts on biological and possible cultural resources would be severe. Likewise, channel diversions to the Baraboo River, Long Lake, or Big Slough are not recommended because the costs would be far greater than the benefits, and impacts on biological, cultural, social, and recreation resources would be severe.

Alternatives involving new reservoirs or increasing flood storage of the existing reservoir system need not be considered further since these alternatives would not protect Portage from large floods. Also, the costs would clearly outweigh benefits and there would be moderate to severe adverse impacts on biological, cultural, and social resources.

Except for acquisition, none of the nonstructural measures by themselves were considered to be a complete solution to the flood problems within the study area. However, a combination of nonstructural measures or nonstructural measures used in addition to a structural alternative was recommended for further study because of the potential to develop a complete plan using this approach. Also, environmental and cultural impacts would be limited with implementation of such non-structural measures.

Generally, the physical and economic feasibility of protecting the floodplain area with nonstructural measures such as floodproofing (by structural raises, walls, or closures) and acquisition was considered doubtful because of the high initial cost and the associated social dislocation impacts. However, because of the identified benefits of removing the problem from the floodplain, additional study of the acquisition alternative may show otherwise. Of the remaining non-structural measures, adoption of floodplain regulations, consistent application of a flood insurance program, and use of the sound flood warning and evacuation plan may be appropriate for the study area with or without a recommended structural alternative.

The no action alternative maintains the status quo -- the Wisconsin Department of Natural Resources would continue to maintain the existing levees, and floodplain regulations and insurance would continue to be enforced and available, respectively. Although the existing situation is functioning, there are expressed problems such as inadequate protection, restriction on floodplain development, and lack of confidence in continued levee maintenance. The no action alternative will, however, continue to be used as a basis for further study recommendations.

In summary, the alternatives worthy of additional formulation and screening are listed below. Also, the following figure provides a visual summary of the plan formulation process completed so far.

1. Improvement of the Portage levee.
2. Improvement of the Portage levee and construction of a new levee in Lewiston Township.
3. Ring levee for Portage.
4. Nonstructural measures for the floodplain area.
5. No action.

Plan formulation process
(Summary of initial actions)

Potential problems	Identified problems	Alternatives considered	Alternatives recommended for further study
Flooding in Portage	Yes	No action Portage levee Ring levee Portage/Lewiston levee All levees Caledonia outlet Channel modifications Diversions Reservoirs Nonstructural	No action Portage levee Portage/Lewiston levee Ring levee for Portage Nonstructural
Flooding in the rest of the study area	Yes	No action Portage/Lewiston levee Caledonia levee All levees Caledonia outlet Channel modification Diversions Reservoirs Nonstructural	No action Portage/Lewiston levee Nonstructural
Other water resource problems	None	-----	-----
Basis for floodplain information reports		A detailed floodplain analysis was completed as part of this study and was used in conduct of a new flood insurance study for Columbia County prepared under the guidance of the Federal Emergency Management Agency.	

REFINEMENT OF ALTERNATIVES RECOMMENDED FOR FURTHER STUDY

The next action in a formulation analysis is to refine alternatives that have been recommended for further study. Each alternative is discussed in detail and, from this refinement or reiterative formulation process and subsequent evaluation, an overall plan was selected. Besides updating the flood damage data and other base information used in critically evaluating the alternatives, this refinement considered the degree of flood damage reduction, the specifics of alternative features, the economic and environmental acceptability, and the overall alternative implementability. A discussion of the refinement for each alternative is presented in the following paragraphs.

DEGREE OF FLOOD DAMAGE REDUCTION

The alternatives recommended for further study were designed to provide for different levels of protection depending on the type of alternative considered. In general, the levels of protection include the 100-year flood event (a flood having a 1-percent chance of occurring in any given year), the 500-year flood event (a flood having a 0.2-percent chance of occurring in any given year), and the standard project flood (SPF - a flood that would result from the most severe combination of meteorologic and hydrologic conditions reasonably characteristic of the region). Specifically, the degree of flood damage reduction used in each alternative was:

Alternative	Level of protection
No action	Existing conditions
Portage levee	100- and 500-year
(different flood protection levels were needed to identify the optimum scale of development)	
Portage/Lewiston levee	Standard project flood
Ring levee for Portage	Standard project flood
Nonstructural	100-year

SPECIFICS OF ALTERNATIVE FEATURES

The specifics of alternative features include levee alignments, design considerations, interior drainage, and other technical aspects important for proper functioning of each alternative. Sound engineering criteria and analysis were used for this purpose.

ECONOMIC AND ENVIRONMENTAL ACCEPTABILITY

Economic acceptability focuses on refinement of the alternatives that best contribute to national economic development (that is, the alternatives that provide the greatest net benefits to the human and physical environment). Economic assumptions include:

a. The base economic condition assumes that the existing levees offer no protection.

b. Annual costs and benefits are based on a 100-year economic life, an interest rate of 8-1/8 percent, and price levels and conditions existing in October 1983.

c. Operation and maintenance costs were included for all alternatives.

Environmental acceptability assures that the alternatives identified as satisfying economic criteria also incorporate the visual, human-cultural, and environmental amenities necessary to protect the Nation's environment.

ALTERNATIVE IMPLEMENTABILITY

Implementability relates to the requirements of technical feasibility and cultural acceptability and the potential for each alternative to receive support by non-Federal interests. Satisfaction of the study objectives is also important.

No Action Alternative

This is the condition anticipated to occur in the future. It is identified by analyzing the existing setting, the trends now developing, and the limitations of the study area resource base. Additional information is presented in the "Future Without Condition" section.

As discussed in the description of alternatives section of this appendix, floods and flood problems would continue in the county and a large portion of the study area would remain under floodplain classification. Although the existing levee system would continue to be maintained by the Wisconsin Department of Natural Resources, none of the levees including the Portage Canal lock area meet standards for permanent flood protection works. Consequently, flood hazards would continue to threaten the health and well-being of over 1,000 people and cause damage to property and interruption of basic services.

Because of this flood threat and the results of the recently completed flood insurance study, the city of Portage and Columbia County have converted from the emergency phase of the National Flood Insurance Program to the regular phase, making purchase of flood insurance for properties in the floodprone area a costly way of life. Therefore, it is expected that only some of the Portage and Pacific floodprone residents will participate. The remaining floodprone residents will have to live with the existing situation.

With this alternative, some changes in the type and extent of flood damages would result in the urban Portage area as structures are either removed from the floodplain or floodproofed under a home improvement effort or under the Department of Housing and Urban Development's Block Grant Program for Community Development. However, given the difficulty and cost of floodproofing, the historical importance of the area, and the fact that few changes have occurred over time, it is unlikely that many structures would be affected. Some floodproofing may be accomplished by

property owners on an individual basis. The type and degree of floodproofing will depend on the preference of the property owners. Generally, however, this activity will be extremely limited for the depth of flooding and the types of structures that exist in the floodplain area. Also, any flood damage reduction would likely be offset by the increase in residential and commercial business content values. Additionally, the no action alternative does little to reduce flood damages in the rural floodplain areas.

The existing flood forecast, warning, and temporary evacuation plan will continue to be in effect for the county. This plan discusses in detail the following:

a. Routine levee maintenance.

b. River stage surveillance including steps to be taken during emergencies.

c. Flood alert plan including command post, on-site commander, command group, surveillance teams, support teams, personnel assignments, and equipment.

d. Post-alert details.

e. Administrative details.

In general, this plan is complete and serves as an important aspect of any future flood control efforts in the county. However, this plan does not eliminate the serious potential for significant flood damages and losses to occur.

Portage Levee

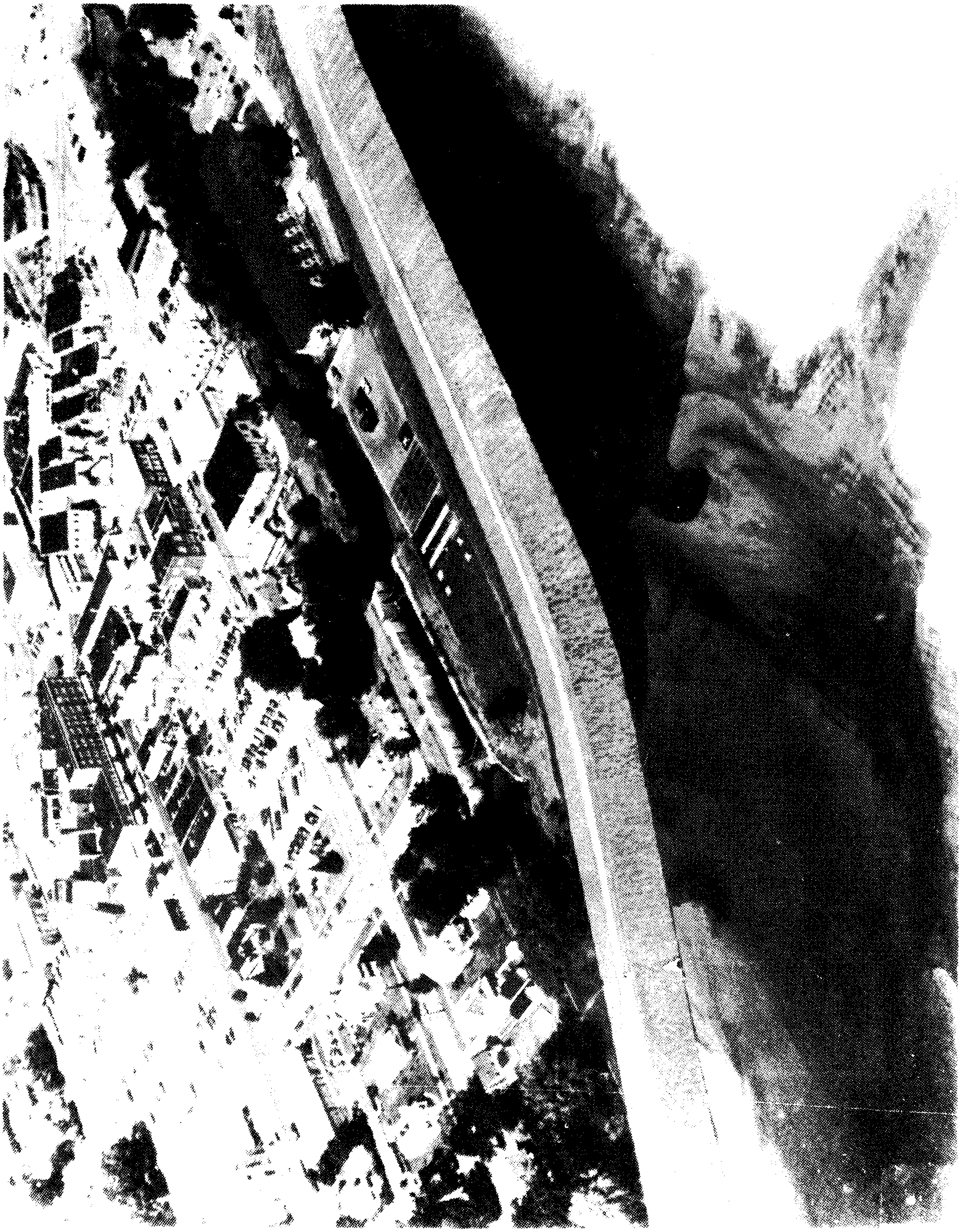
This alternative involves raising, widening, and modifying the existing levee system located within the city of Portage and the town of

Pacific. Additional levees would be constructed in Portage near the Highway 33 bridge and upstream in the Summit Street area (Ward 8).

Main features of this alternative would include approximately 3 miles of levee, 0.2 mile of road raise, 550 feet of floodwall, acquisition of 2 residences, crossing of the Portage Lock and Canal, road ramps, railroad stop log closure, highway sandbag closure, an interior drainage pumping station, and necessary additional collection works for seepage and surface runoff. Aesthetic treatment measures would be included at intervals along the levee and topsoil/seeding or riprap would cover the levee. Recreation facilities would be incorporated.

Four important considerations were analyzed in refinement of this alternative to arrive at the overall levee plan. First, the crossing of the Portage Canal and Lock area is important since the site is a National Historic Landmark. Second, the alignment is important from a technical, social, and environmental aspect. Third, specific levee features were considered to allow the alternative to function as intended. Finally, the degree of protection is important to permit selection of an optimum level of flood damage reduction for the Portage area. Each consideration will be discussed in the following paragraphs.

The Portage Canal and Lock area is a property listed on the National Register of Historic Places. Because of this significance, two options were considered for this area. Option 1 included extending the Portage levee across the mouth of the canal. A gatewell would be located in the levee to permit a continuous source of fresh water for the canal. The second option included incorporating the Portage Canal Wisconsin River Lock into the alternative by relocating and raising the levee on the southeast side of the lock, replacing the existing upper lock gates, and then using a floodwall on the northwest side of the lock to tie the project into high ground. A floodwall is needed there because of the space limitation of the existing topography. The following figures provide an artist's conception of how these two options would look.



Option 1 - Extended Levee Across Mouth of Canal

Costs were developed for each option. Although it would be less expensive to use the levee option, mitigation measures would be necessary to offset the visual and operational elements which would be out of character with the canal and its use and setting. Mitigation would be difficult and the cost would be high, at least equal to the initial difference between options 1 and 2. For option 2, no mitigation would be necessary; however, cultural resource considerations would include aesthetic measures to maintain the historical character of the lock. These include appearance and salvaged materials as discussed in the EIS. Although the options would have similar costs, incorporating the lock into the levee alternative would be more socially acceptable.

Different alignments for the Portage levee alternative were considered based on geotechnical design, avoidance of important environmental areas, avoidance of significant social impacts, cost, and social preference. The alignment which best fits these requirements is described below.

Northwest portion of the city. - This portion of the alternative consists of a road raise which would begin at the River Street and Summit Street intersection and follow Summit Street south until high ground near West Carroll Street. Necessary road ramps would be provided on both River and West Carroll Streets. Following Summit Street was of little advantage geotechnically except for the added stability because of the increased levee width.

Using this alignment, it would be possible to avoid a backwater-wetland area. Social impacts would be limited to one home which would have to be acquired; this home would fall outside of the leveed area. On the basis of cost, this alignment is preferred because less fill would be needed to raise the existing road which is presently about 8.5 feet above the normal ground level.

South central portion of the city. - The levee would begin at West Conant Street, extend through Pauquette Park, and tie into the west side of the State Highway 33 bridge. The levee would continue downstream to almost Dunn Street.

This alignment would have beneficial economic and social effects since it follows the existing levee through the park area and it avoids the significant cost of acquiring up to 20 homes along Edgewater Street. However, approximately 3 acres of the riverine environment would be affected because the levee along Edgewater Street would project out into a portion of the main river channel and a shallow backwater area.

Southeast central portion of the city. - A floodwall would begin near Dunn Street and extend to the Portage Lock. An earth levee would begin at the lock and extend to Ontario Street, following the existing levee alignment.

Using any other alignment in this area would result in significant social and economic effects on the area, because several homes and businesses would be acquired and the existing transportation routes provided by U.S. Highways 16 and 51 would be impaired. Encroachment on the river would also affect approximately 8 acres of a shallow backwater environment. This effect would not be considered adverse because the area has a low aquatic value due to its shifting sandy substrate and rapid water level fluctuations.

Downstream of the city. - The existing levee extends southeast from Ontario Street through a heavily wooded area until it reaches U.S. Highways 16 and 51. Consideration was also given to extending the levee along the southwest edge of the highways. Either alignment would require crossing U.S. Highway 51 and the railroad tracks in the vicinity of County Road G with a ramp and a stop-log closure, respectively. The road ramp would be only 1 to 2 feet high (depending on the degree of flood protection) and a sandbag closure would be used to provide the necessary

freeboard. In comparison, the latter alignment would be shorter, less costly, and generally avoid significant adverse environmental impacts. Because of the environmental consideration for these alignments, the EIS discussed each alignment as an alternative in order to provide a better understanding of the evaluation that was accomplished. For formulation purposes, however, an alignment change is not considered a different alternative.

For this levee alternative, specific features which are important for proper functioning of the levee include levee design, seepage control, erosion protection, and interior drainage. Based on geotechnical design, the levees at Portage would have a 10-foot top width, 1 on 3 riverward side slopes, and 1 on 5 landward side slopes. In addition, a sand berm would be required on the landward side of the levee downstream of Ontario Street. The lack of impervious materials in the area and the use of sand as a levee fill account for the flattened landward slopes and berm. The berm size (width) increases with greater degrees of protection because of the increase in seepage quantities and uplift pressures. Also, the berm decreases when incorporating the existing U.S. highway embankments into the design. The road raise would have side slopes similar to those of the levee and would be constructed to existing roadway widths. Design criteria require 3 feet of freeboard above the design floodwater surface. Riprap protection is proposed where wave action and flowage currents would cause erosion of the levee near the riverbank. For the remainder of the levee areas, topsoil and seeding would be provided to reduce erosion potential. Drainage blocked by the levee/floodwall barriers and any excessive seepage would be controlled by interior drainage facilities. The canal and low areas would be used to reduce the size of these facilities.

Two degrees of flood protection were considered for this alternative - 100- and 500-year. Standard project flood protection was not considered with this alternative because of the overflow problem upstream in the Lewiston area causing Fox River flooding in the Ward 1 area of

Portage. The 100-year level of flood protection was considered minimum, which is consistent with the State of Wisconsin Floodplain Management Program. A 500-year flood was considered maximum because of Wisconsin River overflow problems.

At either degree of flood damage reduction, this alternative is implementable and supported by the city of Portage (see the public involvement appendix).

Portage/Lewiston Levee

This alternative provides for standard project flood protection at Portage. It includes the same general alignment and all of the features discussed in the Portage levee alternative with two exceptions. First, the height and width of the Portage levee alternative would be increased in all areas to provide for the higher degree of flood damage reduction. The increase in levee size would require adjustments in almost all of the specific features; the most significant changes would occur at the Portage Canal lock area and downstream of Ontario Street. The second exception requires that an additional levee be provided in the Lewiston area to prevent flooding in the Ward 1 area of Portage as a result of Wisconsin River overflows into the Fox River upstream of Portage. These main differences will be discussed in the following paragraphs.

In the Portage Canal lock area, this alternative would involve rebuilding a major portion of the lock by raising the lock walls and providing new upper gates. Although the reconstructed locks could be made to resemble the original lock, or some other form that the lock had in the past, the visual impacts would be significant.

This alteration of the lock would be irreparable, and significant mitigation measures would be required. Quite likely, when providing the standard project flood level of protection, the option of placing a continuous levee across the mouth of the canal would be preferred because

it would have less structural impact on the historic property. In addition, this plan would be less costly, although significant mitigation measures would still be necessary.

Downstream of Ontario Street, two important changes would be required in developing a levee to provide standard project flood protection. First, the width of the sand berm on the landward side of the levee would be increased to control the corresponding increase in underseepage pressures. In comparison, berm widths would be 2½ times greater for the standard project flood than for the 100-year level flood protection. Second, standard project flood levee would be 7 feet higher than the existing U.S. Highways 16 and 51. A road ramp would not be possible without significantly disrupting the traffic pattern to and from businesses in the area. Therefore, a closure structure would be used for crossing both the highway and the railroad in that area.

A 5.1-mile new levee would be required to prevent Wisconsin River overflows into the Fox River basin. This levee would follow along the south side of the Chicago, Milwaukee, St. Paul, and Pacific Railroad from near the NW¼, NE¼ of Section 27, T.13N., R.8E. (Lewiston, Wisconsin, 7.5-minute quadrangle) to the SE¼, SE¼, of Section 34, T.13N, R.8E. (Pine Island, Wisconsin, 7.5-minute quadrangle). Another option of raising and extending the existing Lewiston levee was considered; however, the environmental problems and costs were significant.

The specific features for the Lewiston levee would be a 10-foot top width, 1 on 3 riverward side slopes and 1 on 5 landward side slopes, and 3 feet of freeboard above the design floodwater surface. Interior drainage would not be a problem and topsoil/seeding would be used for all faces of the levee.

This alternative would protect almost the entire north bank of the Wisconsin River to a standard project flood level. No additional protection would be provided to the south bank and, in fact, there would

be an increase in the flood potential for Caledonia Township. Flowage easements would be acquired from landowners on the south side of the river to compensate them for increased flooding induced by implementation of this alternative.

The environmental impacts of this alternative would be similar to those discussed for the Portage levee from the upriver end of the project downstream to Ontario Street. From Ontario Street to the downstream end of the project, the standard project flood levee would have a severe impact on both the emergent and floodplain forest wetland areas. The Lewiston levee would affect 50 acres of agricultural, old field, and grass lands. This alternative would require considerable compensation.

Ring Levee for Portage

This alternative was derived from a Fish and Wildlife Service recommendation and would consist of (1) a ring levee around the Ward 1 area located in the southeast portion of the city, (2) a levee in the Pauquette Park area, and (3) a road raise in the Summit Street area. The latter two components and that in the lock area would be similar to those described in the Portage levee alternative. The alignment of the ring levee from the Portage Canal lock would be as follows:

a. South - Starting at the lock, the ring levee would follow the existing Portage levee downstream along the southern edge of U.S. Highways 16 and 51 until it reached the junction of Ontario Street with U.S. Highway 51.

b. East - After crossing U.S. Highway 51, the levee would continue parallel to the east side of Ontario Street (avoiding the homes) and extend northeast to the Chicago, Milwaukee, St. Paul, and Pacific Railroad tracks.

c. <u>North</u> - The levee would continue northwest along the southern edge of the railroad tracks to the Wauona Trail Road and then northeast to a point where the levee would tie into State Highway 33. One alignment option would be not to cross the railroad tracks but to continue the levee along the southern edge of the tracks until it reached high ground after crossing the Portage Canal. The initial alignment option is preferred since it incorporates a majority of the city with little additional environmental problems.

Specific features of this alternative would be road ramps and/or closure structures at all main road or railroad crossings, a closure structure for the canal at the northeast part of the levee alignment, floodproofing for the few scattered dwellings east of the levee alignment, and acquisition/evacuation of most of the trailer park. Geotechnical designs would be similar to those for the other structural alternatives, with levee top widths of 10 feet and side slopes of 1 on 3 riverward and 1 on 5 landward. Berms would be needed for all areas away from the river and a pumping station would be used to handle blocked drainage. Riprap would be used only on the part of the levee next to the Wisconsin River, while topsoil and seeding would be used elsewhere.

This alternative is being considered instead of developing the upstream Lewiston levee. Therefore, the degree of protection will be limited to standard project flood protection.

Environmentally, this alternative would have a severe impact on the Portage Canal, a historic site, through two closure structures. Effects on the natural environment would be similar to those described for the Portage levee alternative. In addition, the portion of the ring levee along Ontario Street would affect 4 acres of floodplain forest. Although compensation would be required for these effects, the details were not determined.

Nonstructural Alternatives

Four nonstructural alternatives were recommended for further study including: acquisition of the structures in the floodplain; floodplain regulations; flood insurance; and flood forecasting, warning, and evacuation. Only acquisition of structures in the floodplain will be discussed here since floodplain regulations, insurance, and warning systems have already been discussed in the no action alternative. The latter three measures are expected to occur in the future.

Under this alternative, all of the residential structures and businesses in the Ward 1 and 8 areas of Portage and in the Blackhawk Park area of Caledonia Township would be acquired. This acquisition would occur based on the desires of individual property owners. The entire evacuation plan would not be completed for many years. The floodprone structures around Pauquette Park would be floodproofed. It is not economical or practical to acquire or uniformly floodproof the remaining residential/business structures in the Columbia County floodplain since many are seasonally inhabited and are scattered throughout the area.

All properties to be acquired would be purchased and the owners would be assisted in finding replacement properties. The purchased structures would be cleared from their sites. The evacuated sites would be graded, seeded, and planted with appropriate vegetation for reasons of public safety and aesthetics.

A significant number of displaced homeowners might wish to move their homes to new sites. In these cases, individuals would be offered their structures for repurchase at salvage value and advisory assistance would be provided by the Corps of Engineers for moving the structures.

To ease the potential housing shortage which might be caused by the evacuation, all remaining houses for which it is desirable and feasible would be relocated, renovated, and made available for purchase as replacement housing as part of the project.

The acquisition would require purchase of the residential and business structures partially occupying approximately 42 city blocks within Portage and 3 sections in Caledonia Township. Sufficient residential land in the city and county would have to be made available, with and without existing dwellings, to accommodate all evacuated persons who wished to relocate there. It would be the responsibility of the city/county to insure that sufficient improved lots for new or relocated dwellings were ready by the time of project implementation to meet the demand for them. Before evacuation took place, the availability of replacement dwellings for all displaced residents would have to be assured.

There would be no change in the floodplain management ordinance and therefore, any possible changes in floodplain regulation would be independent of project implementation. The existing regulation affects properties and individuals in all areas of the county floodplain.

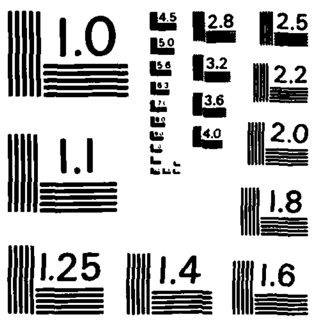
All property owners with property remaining in the floodplain subject to floodplain regulation could, at their option, obtain technical assistance in floodproofing their structures. This assistance would help them to determine which measures are best suited to their structures.

All persons who would be displaced from their business locations, homes, and/or homesites as a result of this project would receive the benefits provided for in the applicable Federal and State laws in addition to the purchase price of any property which would be acquired. The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646), which applies to all land purchases for federally assisted projects, provides for the following:

AD-A148 351 FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT WISCONSIN RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 83

2/9

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

a. Every reasonable effort shall be made to acquire real property promptly by negotiation.

b. The owner or his designated representative shall be given an opportunity to accompany the appraiser during his inspection of the property.

c. Before the start of negotiations, an amount would be established as just compensation and a prompt offer would be made to acquire the property for that amount. In no event shall the amount be less than the concerned agency's approved appraisal of the fair market value of the property. The owner would be provided a written statement of, and a summary of the basis for, the amount established as just compensation.

d. An owner would not be required to surrender possession of real property until he is paid the agreed purchase price or until a deposit is made with the court, for the benefit of the owner, in an amount not less than the concerned agency's approved appraised value or in the amount of the award of compensation by the court.

e. The construction or development of a public improvement would be scheduled to the greatest extent practicable to give the owner at least 90 days written notice to move.

f. If the acquisition of real property would leave the owner with an uneconomic remnant, an offer would be made to acquire the entire property.

Public Law 91-646 requires that all persons displaced by land acquisition actions of a federally assisted program be fully advised of the benefits available to them to minimize any adverse impacts. In general, the law seeks to provide displaced residents with housing at least equal to that which was vacated. Persons living in substandard housing who are displaced would be assisted in moving into other housing which meets

minimum standards with respect to decency, safety, and sanitation. This type of benefit is entirely separate from, and in addition to, the price paid for the property acquired. Some additional requirements are included in Wisconsin's relocation law and would be the responsibility of the local sponsor.

Land use controls consistent with Wisconsin, city, and county floodplain management objectives would prevent unwise development from recurring in the evacuated area.

SELECTING A PLAN

A plan can be identified recognizing the economic, environmental, and implementability aspects of the refined alternatives. An alternative or combination of alternatives that best satisfies these requirements can therefore be included as part of a plan. For the study area this is consistent with the overall study objectives described earlier. The primary criterion is economics. The refined alternative(s) must provide the most cost-effective solution from a national perspective. A secondary criterion is the environment, as it is important to protect the Nation's environment. The third criterion is implementability, which is guided by social acceptance. Evaluation of the refined alternatives based on these three criteria is discussed in the following paragraphs.

ECONOMIC EVALUATION

The following figure presents an economic comparison of the refined alternatives which is accomplished by assessing the costs and benefits. Estimating the cost of each alternative is a relatively straightforward procedure consisting of estimating the first cost or construction cost based on implementation of the alternative features discussed. The average annual costs are alternative costs reduced to an average annual

basis by compound interest methods. Costs are negative contributions to the Nation's development. The benefits for the refined alternatives are based on the amount of flood damage reduction attributable to each and are determined by knowing the modifications or flood damages of the area. Benefits are positive contributions to the national economic development. Net contributions are the difference between positive and negative values and are the standard by which the alternatives are compared. The benefit-cost ratio is the relation of benefits to costs and represents the degree of economic justification of a project.

Economic evaluation of refined alternatives ($1,000's)

Economics	Refined alternatives					
	No action	Portage levee(1)	Portage levee(2)	Portage/ Lewiston levee	Ring levee for Portage	Nonstructural (evacuation)
First cost	No evaluation since this will occur in the future.	6,787	7,238	11,765	13,000	15,622
Average annual cost (3)		615	655	1,064	1,209	1,270
Average annual benefits		733	938	972	972	746
Net benefits		+118	+283	-92	-237	-524
Benefit-cost ratio		1.2	1.4	0.91	0.8	0.59

(1) Developed to provide Portage with flood protection from a 1-percent chance flood.
(2) Developed to provide Portage with 500-year flood protection.
(3) Includes interest and amortization for 100-year life at an 8-1/8-percent interest rate and additional charges for operation and maintenance.

Of the refined alternatives, the Portage levee alternative developed to a 500-year level of flood protection has the highest net benefits. The same alternative with a 100-year level of flood protection still has a positive benefit-cost ratio but has less net benefits. The net benefits of the Portage/Lewiston levee alternative are negative and incremental justification is lacking. Likewise, the ring levee and evacuation alternatives have negative net benefits. Therefore, the economic evaluation indicates that a Portage levee alternative developed to a 500-year level of flood protection best satisfies the national economic development objective.

ENVIRONMENTAL EVALUATION

An environmental comparison is accomplished by reviewing the beneficial and adverse contributions that would occur from development of the refined alternatives. The following figure presents a summary of the overall biological resources which would be impacted. A detailed description/discussion of the impacts is presented in the final environmental impact statement section of the main report. However, the overall environmental evaluation indicates that any of the refined alternatives could be developed consistent with protecting the historic and environmental importance of the area. Slight preference might be given to the nonstructural alternative of evacuation since it removes the human impact on the biological systems and, in turn, the floodplain would probably become more productive and/or diverse.

Relative environmental impacts of alternatives

Proposed alternative	Biological	Cultural Resource	Social Resources	Outdoor Recreation
Levee Improvement				
Portage	Adversely affect riparian hardwood forest & wetlands	Potential for impacting unrecorded archeological sites	Significantly reduce social impacts that accompany flooding	Potential for new trails and other amenities
Portage/Lewiston	Adversely affect riparian hardwood forest & wetlands	Potential impact to recorded archeological site	Negative social impacts in Caledonia	Potential for new trails and other amenities
Ring	Adversely affect riparian hardwood forest & wetlands	Adverse effects on Portage Canal	Adverse social impacts	Disruption of current uses
Nonstructural	No impact	Potential for significant adverse impact	Potential for significant adverse impact	No impact
No Action	No impact	No impact	No impact	No impact

IMPLEMENTABILITY EVALUATION

Implementability of a particular alternative depends upon six major factors:

a. Technical feasibility
b. Economic feasibility
c. Social acceptability
d. Environmental acceptability
e. Cultural acceptability
f. Support

The first five factors were used in the formulation analysis to identify, screen, and refine each of the flood damage reduction alternatives for the study area. The alternative which satisfies the requirement of implementability in the Portage area is the Portage levee alternative. Support for this alternative is documented by letter dated 30 September 1983. Based on decisions made at the last citizens committee meeting and on the Institutional Analysis Report, the no action alternative is favored by the rest of the study area. Appendix J presents a discussion of this support. For the nonstructural alternative of evacuation, implementation is questionable because of economics and support. Since the evacuation alternative is not feasible, the type of evacuation that would be considered is long-term evacuation. This would be accomplished over time as residences (floodplain) became available. The Corps of Engineers would not participate in such a long-term effort and, therefore, implementation would depend upon the actions of a non-Federal interest. No such actions have been expressed to date. Likewise for the Portage/Lewiston levee alternative, implementability is not a possibility because of the lack of feasibility, the problems with the Portage Canal area, and the increased flood problems in the Caledonia area.

SUMMARY

The economic, environmental, and implementability aspects of the refined alternatives have been considered in the preceding paragraphs. A summary is presented in the following figure.

Plan formulation process

[illegible]	[illegible]	Alternatives considered	Alternatives recommended for further study based on preliminary screening	Refinement of alternatives recommended for further study: Lock area	Alignment	Degree of protection	Economic feasibility	Environmental acceptability	Implementability	(5) Selected plan
Flooding in Portage	Yes	No action Portage levee Ring levee Portage/Lewiston levee All levees Caledonia outlet Channel modifications Diversions Reservoirs Nonstructural	No action (base condition)					Yes	No	
			Portage levee	Levee across channel	Existing	100-year	Yes (1)			
						500-year	Yes (1)	Yes(4)	Yes	
				Incorporating lock with levee	Modified	100-year	Yes (1)			
						500-year	Yes	Yes	Yes	> Modified Portage levee with 500-year degree flood protection and lock incorporated into levee.
			Portage/Lewiston levee	Levee across channel Incorporating lock with levee	Existing Modified	SPF	No (2)	Yes(4)	No (3)	
			Ring levee	Levee across channel Incorporating lock with levee	Existing or Modified	SPF	No	Yes(4)	No	
			Nonstructural				No			
Flooding in rest of study area	Yes	No action Portage/Lewiston levee Caledonia levee All levees Caledonia outlet Channel modification Diversions Reservoirs Nonstructural	No action (base condition)					Yes	Yes	> Floodplain regulation and flood insurance for Columbia County.
			Portage/Lewiston levee	Levee across lock Restructuring lock	Existing Modified	SPF	No (2)	Yes(4)	No (3)	
			Nonstructural				No			
Other water resource problems	None									
Needs for floodplain information reports	Yes	A detailed floodplain analysis was completed as part of this study and was used in conduct of a new flood insurance study for Columbia County completed under the guidance of the Federal Emergency Management Agency.								

(1) This alternative is economically justified but does not provide for the greatest economic net benefits.
(2) This alternative is not economically justified.
(3) This alternative lacks implementability because of economic justification, major adjustments in the Portage Canal area, and increased flood damages in Caledonia Township.
(4) Would require fish and wildlife mitigation.
(5) Since there is only one alternative in each area worthy of being identified as the selected plan, an additional discussion of tradeoffs and evaluation is not needed to complete the formulation process.

The plan formulation analysis indicates that there is only one alternative in each flood problem area that is worthy of being included in the final plan. Therefore, these alternatives constitute the selected plan. This consists of implementation of a 500-year flood control levee at Portage with modifications to the existing alignment and careful incorporation of the historic Portage Canal lock into the levee plan. For the remaining floodprone areas of the basin, participation in floodplain regulation and flood insurance is included in the selected plan. Finally, the selected plan in combination with the detailed floodplain analysis completed as part of this study entirely satisfies the overall study objectives discussed earlier.

SCALE OF DEVELOPMENT

The formulation process included a rather complete analysis of the economic conditions of the Portage levee alternative. However, this section confirms that the degree/level of flood damage reduction selected for the structural alternative is the optimum economic level. Results of the optimization analysis are discussed in the following paragraphs.

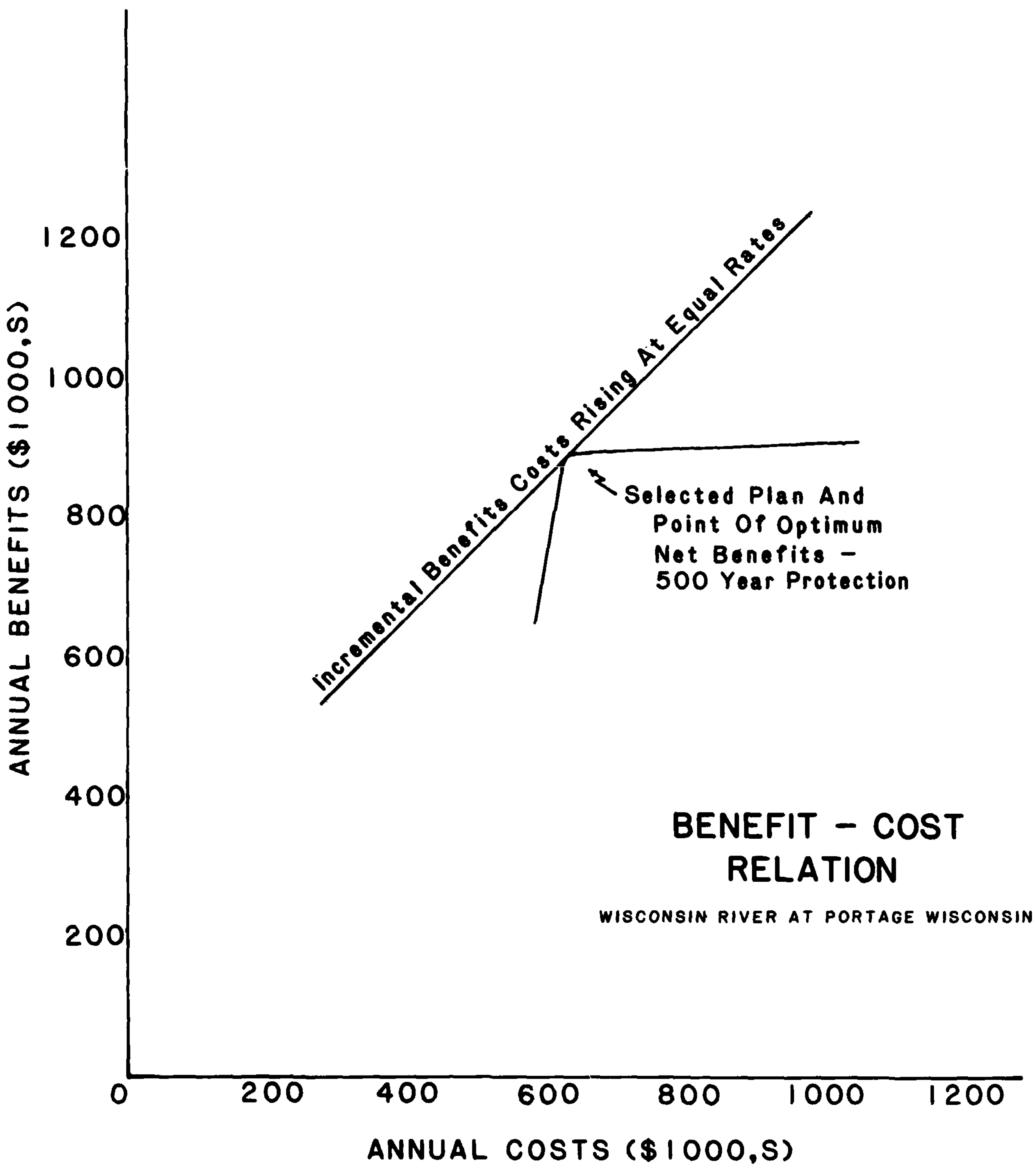
From an analysis of the 100-year, 500-year, and standard project flood levels of protection, an optimum relationship between average annual costs and benefits for the entire project exists when flood protection is provided against a flood having a recurrence interval of once in about 500 years. An increase in the level of flood protection to the standard project flood level would not be economically justified and would be extremely difficult to implement because it entails a much different plan that impacts significantly on other floodprone areas of the county. In addition, four major impediments occur at the standard project flood level including a significant adverse impact on the Portage Canal lock (a property identified on the National Register of Historic Places), a large change in structural design of the Portage levee, the induced damages in the Caledonia Township area, and the local unacceptability.

The following figure gives economic data for the three degrees of flood damage reduction:

Plan optimization data ($1,000)

Plan	Degree of protection (in percent)	Annual benefits	Annual costs	Net benefits	Benefit-cost ratio
Portage levee	1 (100-year)	733	615	+118	1.2
Portage levee	0.2 (500-year)	938	655	+283	1.4
Portage/Lewiston levee	0.03 (Standard project flood)	972	1,064	- 92	0.91

The following figure shows average annual benefits and costs graphed on a linear scale. Maximum net benefits on the graph are the point at which benefits and costs are increasing incrementally at the same rate. This figure demonstrates that the point of optimum net benefits is at the selected level of development (500-year protection).


Incremental Benefits Costs Rising At Equal Rates
Selected Plan And Point Of Optimum Net Benefits - 500 Year Protection
BENEFIT - COST RELATION
WISCONSIN RIVER AT PORTAGE WISCONSIN
ANNUAL BENEFITS ($1000,S)
ANNUAL COSTS ($1000,S)
0
200
400
600
800
1000
1200

FEASIBILITY STUDY FOR FLOOD CONTROL

WISCONSIN RIVER

at

PORTAGE, WISCONSIN

APPENDIX B

HYDROLOGY

December 1983

APPENDIX B

HYDROLOGY

TABLE OF CONTENTS

TABLES

TABLE OF CONTENTS (Continued)

TABLES

PLATES

TABLE OF CONTENTS (Continued)

PLATES

TABLE OF CONTENTS (Continued)

PLATES

APPENDIX B
HYDROLOGY

CLIMATOLOGY

GENERAL

The study area for the Wisconsin River at Portage feasibility study is shown on plate B-1. The climate of the study area is continental with warm summers and cold winters. The average growing season is about 150 days, from the last spring freeze in early May to the first fall freeze in early October. The mean annual temperature for the Wisconsin River basin is about 44° F with monthly averages varying from 15° F in January to 71° F in July. Monthly and mean annual temperatures for selected locations within the basin are shown in the following table.

Monthly and Mean Annual Temperatures

Month	Rhinelander	Merrill	Wisconsin Rapids	Portage	Prairie du Chien
January	12.3	13.2	14.2	18.4	19.0
February	15.1	16.1	17.5	22.0	23.1
March	25.9	26.8	28.4	32.3	33.7
April	42.1	43.4	44.3	47.8	49.4
May	54.0	55.0	55.7	58.9	61.7
June	63.5	64.3	65.5	67.9	70.0
July	67.7	68.8	69.8	72.3	74.1
August	65.9	67.0	68.2	70.6	72.8
September	56.9	57.7	58.7	61.9	63.8
October	47.5	48.0	48.8	52.4	53.5
November	31.0	32.0	32.9	36.8	37.5
December	17.7	18.7	19.5	23.5	24.2
Annual	41.6	42.6	43.6	47.1	48.5

PRECIPITATION

Normal annual precipitation varies slightly within the basin. Average annual precipitation is about 31 inches, 60 percent of which occurs between May and September. The mean annual snowfall is approximately 36 inches for the north central portion of Wisconsin and about 30 inches for the central portion. This represents between 10 and 15 percent of the annual precipitation.

National Weather Service hourly recording gages for precipitation are located at the following sites in the Wisconsin River watershed above Portage.

Phelps Deerskin Dam
Rainbow Reservoir
Three Lakes Ranger Station
Prentice
Rice Reservoir
Merrill
Medford
Wausau
Eau Pleine Reservoir
Marshfield Experimental Farm
Babcock
Coddington
Tomah Ranger Station
Friendship Ranger Station
Portage

Monthly and mean annual precipitation for selected communities in the Wisconsin River basin is shown on the following table.

Monthly and Mean Annual Precipitation

Month	Rhinelander	Merrill	Wisconsin Rapids	Portage	Prairie du Chien
January	1.00	0.99	1.01	1.19	1.08
February	0.74	0.76	0.90	1.02	0.92
March	1.50	1.61	1.91	1.89	2.14
April	2.21	2.38	2.79	3.06	2.94
May	3.53	3.93	3.91	3.24	3.94
June	4.42	5.40	4.40	4.15	4.65
July	3.67	3.88	3.43	3.69	3.74
August	3.89	4.03	3.48	3.16	3.62
September	3.80	4.07	3.75	3.87	3.40
October	2.29	2.29	2.26	2.13	2.25
November	1.84	1.94	1.92	1.94	1.70
December	1.14	1.07	1.24	1.36	1.30
Annual	30.03	32.35	31.00	30.70	31.68

STREAMFLOW, RUNOFF, AND FLOODS

STREAMFLOW RECORDS

Wisconsin River

The first record of flood stage and discharge dates from March 1873 on the Wisconsin River at Portage and from October 1934 at Wisconsin Dells. The staff gage at the Portage locks was established by the National Weather Service. It has remained at the same location with minor changes in elevation. This staff gage is read daily by a resident of Portage. The U.S. Geological Survey (USGS) gage, about 3 miles downstream from Wisconsin Dells, is a digital water stage recorder. Before October 1963, a graphic water stage recorder, at a datum 5 feet higher, was used at this location. To supplement these records, interviews and field inves-

tigations were conducted in the area, and a search was made of newspaper files, books, and other historical documents. Based on water surface records, interviews, and field investigations, computations were made to develop flood profiles. This work resulted in a flood history spanning 133 years for the Wisconsin River at Portage.

Baraboo River

The period of record for streamflow gaging on the Baraboo River at Baraboo, Wisconsin, (USGS gage 05-4050) is 1914-21, 1935, 1943-present. For this report the period of record through 1978 was used. The drainage area at Baraboo is 609 square miles. No detailed literature search was conducted to develop additional data to extend the period of record.

Fox River

The only Fox River USGS gaging station is at Berlin, Wisconsin (drainage area = 1,430 square miles, USGS station 05-0735). The period of record is 1881, 1898-present. For analysis for this study, the period of record ends in 1978.

RUNOFF CHARACTERISTICS

The Wisconsin River drains an area of approximately 12,000 square miles in central Wisconsin. Its streamflow is regulated by 21 reservoirs operated by the Wisconsin Valley Improvement Company in the headwaters and on tributary streams. The reservoirs provide water for 26 main stem hydroelectric dams. Prairie du Sac is the only reservoir downstream of Portage. The State of Wisconsin sets operating limits for these reservoirs with a goal of maintaining more uniform flow than what would have occurred without the reservoirs in place. Although no power is generated at these 21 reservoirs, their operation provides for flood control and low flow augmentation in the river.

EFFECT OF LAKE STORAGE

Three large hydroelectric dams, DuBay, Petenwell, and Castle Rock, located on the Wisconsin River just above Portage draw down their pools during the winter to create storage for spring floodwaters. The amount of drawdown varies from year to year, depending upon the level of spring runoff forecast. The operation of these reservoirs, in addition to the storage in the 21 storage reservoirs, has had a significant impact on floods. The Eau Pleine reservoir is the closest to Portage, and the rest are considered to be headwaters reservoirs. The mean annual flood peak at Wisconsin Dells has been lowered 21 percent. However, the three large main stem hydroelectric dams would have a minimal effect on summer and fall floods, because their pools would be nearly full, with little flood control storage available. There are also 22 run-of-river hydropower dams upstream of Portage that have a minimal effect on flood reduction.

WATERSHED CHARACTERISTICS

The Wisconsin River drainage basin has changed drastically since the days of pioneer settlement. New durable dams have been built and most of the original forest cover has been replaced by pasture and cropland. Evaluation of flooding conditions, particularly in the city of Portage, must consider the fact that the levees have been raised and reinforced in a haphazard manner over the years. Flooding in the city can occur when the levees are breached or overtopped. Flooding also occurs in the remainder of the county in Caledonia or Lewiston when their levees are breached or overtopped.

FLOODS OF RECORD

Wisconsin River

Severe flooding from spring runoff has not occurred in recent years because of the Wisconsin Valley Improvement Company's efforts to store spring runoff. With the present reservoir operation policy, severe

flooding from heavy rains is more likely than flooding from spring runoff.

The following table lists flood stages and discharges for known floods which exceed the flood stage of 17.0 feet at the Portage locks. The table on page B-8 lists the ten largest known floods as recorded at the Wisconsin Dells gage.

WISCONSIN RIVER AT PORTAGE, WISCONSIN, FLOOD CREST ELEVATIONS ABOVE FLOOD STAGE (PERIOD OF RECORD 1873-1978)

The table includes all known floods above flood stage of 17.0 feet at the gaging station at the locks in Portage, Wisconsin, at mile 115.0 above the Mississippi River. Drainage area = 7,940 square miles, approximately. Stages adjusted to present gage zero of 773.94, M.S.L. 1929 adjustment.

Date of Crest	Maximum Stage	Crest Elevation	Peak Discharge (cfs)
April 20, 1888	17.1	791.0	41,700
May 4, 1888	17.1	791.0	41,700
October 9, 1900	18.8	792.7	56,200
Sept. 20, 1903	18.5	792.4	53,500
June 11, 1905	18.9	792.8	57,000
Oct. 11-12, 1911	19.2	793.1	59,800
Sept. 7, 1912	18.2	792.1	50,800
June 10, 1914	17.7	791.6	46,500
April 27, 1916	18.0	791.9	49,100
March 31, 1920	18.2	792.1	50,800
April 14, 1922	19.1	793.0	58,800
April 26, 1923	17.2	791.1	42,500
Sept. 20, 1928	18.1	792.0	50,000
April 12, 1929	17.9	791.8	48,200
March 27, 1935	19.0	792.9	64,600
March 29, 1936	17.5	791.4	46,300
Sept. 14, 1938	20.5	794.4	72,200
March 30, 1939	18.2	792.1	48,500
June 29, 1940	18.3	792.2	50,700
Sept. 6, 1941	17.3	791.2	43,600
June 5, 1942	18.4	792.3	52,800
June 4-5, 1943	18.9	792.8	57,500
March 23, 1945	17.3	791.2	43,000
March 19, 1946	17.7	791.6	45,600
April 12, 1951	19.1	793.0	61,700
October 1, 1959	17.7	791.6	43,800
May 10, 1960	19.6	793.5	63,300
April 16, 1965	18.5	792.4	50,200
April 5, 1967	18.8	792.7	51,800
June 29, 1968	17.5	791.5	42,100
July 1, 1969	18.2	792.1	46,300
April 14, 1971	17.1	791.0	36,000
April 21, 1972	18.0	791.9	42,000
Sept. 30, 1972	18.3	792.2	45,500
March 17, 1973	21.1	795.0	62,600
April 30, 1975	17.2	791.1	37,400
April 2, 1976	18.0	791.9	41,000

NOTES:

1. Prior to October 1934, discharges are obtained from the rating curve at Portage. After October 1934, discharges are as recorded at the Wisconsin Dells gaging station and stage as recorded at Portage.

2. Levees constructed near and at Portage, Wisconsin, from 1880 to 1900, have restricted the flood channel, resulting in higher flood stages for a given discharge.

Ten largest known floods, Wisconsin River
at Portage, Wisconsin
(Period of Record 1873-1978)

Order No.	Date of crest	Maximum stage (feet)(1)	Crest elevation (feet)(1)	Peak discharge (cfs)
1	Sept. 14, 1938	20.5	794.4	72,200
2	Mar. 27, 1935	19.0	792.9	64,600
3	May 10, 1960	19.6	793.5	63,300
4	Mar. 17, 1973	21.1	795.0	62,600
5	Apr. 12, 1951	19.1	793.0	61,700
6	Oct. 11-12, 1911	19.2	793.1	59,800
7	Apr. 14, 1922	19.1	793.0	58,800
8	Jun. 4-5, 1943	18.9	792.8	57,500
9	Jun. 11, 1905	18.9	793.8	57,000
10	Oct. 9, 1900	18.8	792.7	56,200

(1) 1929 adjustment

NOTE: Prior to October 1934, discharges are obtained from the rating curve at Portage. After October 1934, discharges are as recorded at the Wisconsin Dells station and stage as recorded at Portage.

Following are descriptions of large known floods that have occurred on the Wisconsin River in the vicinity of Portage. These are based on newspaper accounts, historical records, and field investigations. High waters of significance have been recorded for 1838, 1845, 1850, 1852, 1880, 1900, 1905, 1911, 1922, 1935, 1938, 1943, 1951, 1960, 1965, 1967 and 1973.

June 1880 Flood

This flood is described as the worst flood before construction of the levees. An excerpt from the Portage Democrat on June 18, 1880, reads as follows: "Never before in the history of floods has so much property been destroyed in the vicinity of Portage. The bottom lands between the Wisconsin and Baraboo Rivers are inundated. The levees in Lewiston gave way Tuesday night, June 15th, and the backwater of the Wisconsin now finds an outlet through Big Slough down Neenah Creek and into the Fox River."

October 1911 Flood

The Wisconsin River flooded again in 1900 and 1905. By 1911, however, the levees had been extended and strengthened. During the October 1911 high waters the levees held, except for the one near Barden Place which let several feet of water onto the Caledonia lowlands. The reading at the Portage locks was within 1 foot of the lock's top. The confidence in the city side levees was exemplified by the Portage Democrat which said in 1911, "If the river rise continues, it is likely the water will go over the levees on the Caledonia side first, and thus, relieve the situation on the city . . . The river certainly would go over the levees in many places and lower the flood before it could reach the top of the lock."

September 1938 Flood

The Wisconsin State Register, Portage, Wisconsin, in its September 15, 1938, edition, noted that the 1911 flood story paralleled the story being written about this flood. Service was suspended on the Milwaukee Road's Madison line and basements were flooded, but the levees were holding. However, the break in the main levee near Tom Turkey Inn was serious. The Register stated, "After the break occurred, nothing was done to attempt to fill the levee break which was about 20 feet wide. The water flowed rapidly northward toward the city in the marshland, covering the highway and spilling through railroad culverts toward the Fox River

drainage system." (Note: Local historians have indicated that the break was filled with old vehicles and random fill.)

Flooding in Caledonia was described in the Register: "The view from the hospital hill out over Caledonia this afternoon resembled that in a lake country. Large areas of the township were under water. The Baraboo River rose 7 inches during the night after rising during the day Wednesday, and there was much flooding from that stream." The levee break would have been even more serious if the river's main channel did not have to cross a lengthy swamp to the break.

May 1960 Flood

The Portage Daily Register in its May 9, 1960, edition had the following to say about the second highest recorded water level in the history of the gage: "The worst flooding in recent years was reported here as the city braced for a 19 foot level on the Wisconsin River." "Locally basements were flooded in the First Ward and along West Edgewater Street next to the Wisconsin River." Portions of West Carroll and Conant Streets were flooded. The levees held and no serious flooding occurred within the city.

Other Floods

The high water of 1951 is recorded at 19.1, the fifth highest stage in the history of the gage. The common high water occurrences are exemplified by a statement from the Portage Daily Register on April 12, 1951. "In the First Ward in Portage, there are many houses with flooded cellars, but that is considered an annual event." The levees were not overtopped or breached that year.

Fox River

The flooding history on the upper Fox River is not as well documented as that on the Wisconsin River. The nearest stream gage on the Fox River is at Berlin (drainage area = 1,430 square miles). However, the dates of

major flooding at Berlin probably also indicate the dates of major flooding at Portage. The ten highest floods during the period of record at Berlin are tabulated below. The average travel time from Portage to Berlin is estimated to be approximately 5 days.

Ten Highest Floods of Record at Berlin (Gage 04-0735)(1)

Date	Peak discharge (cfs)
March 17, 18, 1946	6,900
March 21, 23, 1929	6,620
March 28, 30, 1916	6,400
September 21-23, 1938	6,190
March 21-23, 1918	6,050
April 12, 1923	6,050
March 15, 1973	6,010
March 23, 24, 1928	5,920
June 10, 11, 1905	5,920
March 16, 1922	5,920

(1) Period of record 1881/1898-1978.

High watermarks for the 1973 flood on the Fox River were available. By statistical analysis of gage records at Berlin using the most recent Water Resources Council guidelines with an adopted skew equal to the station skew of -0.300 rounded to the nearest tenth, the 1973 flood was assigned an exceedence probability of 0.07 percent at Berlin. Analysis of other stream gages in the Fox River watershed indicates a similar exceedence probability for the 1973 flood. A 1973 high watermark elevation of 775.7 at section F results in a peak discharge of approximately 1,700 cfs as predicted by the HEC-2 step backwater model developed for the Columbia County Flood Insurance Study in 1979.

High watermarks for the 1881 flood are also available. The Columbia County HEC-2 model predicts a peak discharge of approximately 2,300 cfs from the high watermarks for the 1881 flood; however, the character of

the Fox River has changed since that time. At the time of the 1881 flood, locks existed along the upper Fox River.

Baraboo River

The Baraboo River (drainage area = 609 square miles) is gaged approximately 16.4 miles upstream from its mouth. The dates and magnitudes of the ten highest floods during the period of record are given in the following table.

Ten Highest Floods of Record on the Baraboo River (Gage 05-4050)(1)

Date	Peak discharge (cfs)
March 26, 1917	7,900
June 22, 1920	7,360
April 5, 1959	5,910
February 13, 1966	5,900
March 29, 1950	5,760
March 30, 1961	5,640
April 6, 1956	5,340
March 21, 1948	5,340
August 6, 1935	5,100
July 6, 1978	4,600

(1) Period of record 1914-1921/1935/1943-1978.

FLOOD FREQUENCY CURVES

GENERAL

Discharge-frequency relationships for locations on the Wisconsin River were developed by the Wisconsin U.S. Geological Survey and the St. Paul District. The results of this analysis are published in the USGS Open File Report 80-1103, "Streamflow Model of Wisconsin River for Estimating Flood Frequency and Volume," dated November 1980. Daily simulation was completed for water years 1915-76. Simulation was necessary to make

streamflow values homogeneous for the period of record because the three large hydroelectric dams in central Wisconsin were all constructed after 1940. Streamflow was simulated for two conditions: (1) with no reservoirs in the system, and (2) with all existing reservoirs in place and operating with current rules.

At Wisconsin Dells, typical flood hydrographs for the 10-, 25-, 50-, 100-, and 500-year floods were estimated using simulated data. Volumes of runoff represented by these hydrographs were determined by the frequency-discharge relationship for various durations, as shown on plate B-2. Flood hydrographs for the 10-, 25-, 50-, 100-, 200-, and 500-year floods are shown on plate B-3.

The hydraulic methodology used to develop the frequency-discharge relationships downstream of Wisconsin Dells for the various levee conditions assumed that a perfect correlation exists between the Wisconsin River's peak discharge frequency and volume frequency. All flood hydrographs having a given exceedence probability were assumed to have the corresponding shape given on plate B-3. Assumed levee conditions involving lateral outflow away from the Wisconsin River were analyzed using the "SPILL" program (discussed in greater detail in the hydraulics appendix) whereby the levees or embankments being overtopped could reasonably be modeled as unsubmerged or partially submerged weirs. Frequency-discharge relationships downstream of Wisconsin Dells were developed by modified puls routing of the hydrographs to account for channel storage and thus reduce the channel discharge at each cross section. The reduction in peak discharge due to channel storage was found to be negligible. The effect of lateral outflow was found to be very significant for discharges exceeding the channel discharge of incipient outflow equal to approximately 60,000 cfs (for the levees overtopped but not breached condition). The downstream limit of the Wisconsin River reach involving lateral outflow was found to be section AD (just downstream of the Portage levee).

Three significant streams join the Wisconsin River between Wisconsin Dells and the Prairie du Sac Dam:

a. Dell Creek (drainage area = 44.9 square miles at the mouth)
b. Baraboo River (drainage area = 609 square miles at the gage)
c. Duck Creek (drainage area = 97 square miles at the mouth)

The Dell Creek confluence is upstream of the U.S. Geological Survey gaging station near Wisconsin Dells. Thus, the effect of Dell Creek inflows to the Wisconsin River has been included in the frequency-discharge relationship and the flood hydrographs developed for Wisconsin Dells.

The Baraboo River has a drainage area of 609 square miles at the gage approximately 16.4 miles upstream of its confluence with the Wisconsin River and 629 square miles at the Interstate 90/94 bridge located in the flat land adjacent to the Wisconsin River (see plate B-1). Because of the relatively small local inflow contributing area downstream of the gage, flows at the gage were not adjusted at the mouth, approximately 7.58 miles downstream of the Interstate 90/94 bridge.

WISCONSIN RIVER DISCHARGE-FREQUENCY CURVES WITH AND WITHOUT EXISTING RESERVOIRS

The results of the computer model simulation indicated that the reservoirs have an impact on floods. The mean annual flood peak at Wisconsin Dells was lowered 21 percent from 43,000 cfs for the simulated unregulated condition to 34,000 cfs for the simulated regulated condition. The 100-year flood peak at Wisconsin Dells is reduced 8 percent (92,000 cfs to 85,000 cfs) between the simulated unregulated and simulated regulated conditions with the expected probability adjustment. The 85,000 cfs discharge for the 100-year flood peak at the Wisconsin Dells gage was agreed upon by the U.S. Geological Survey, the Wisconsin Department of Natural Resources, and the Corps of Engineers.

The 100-year flood peak at Wisconsin Dells, computed from the simulated regulated streamflow data for the period 1915-1976, is 85,000 cfs. The simulation included the effects of all the reservoirs in the river system, as they are currently operated. It also included the effects of Lakes DuBay, Petenwell, and Castle Rock which are significant for spring floods but insignificant for summer or fall floods because the lakes are normally kept nearly full in the summer and fall and have little storage for floodwaters. Discharge-frequency relationships for both the simulated regulated and the simulated unregulated conditions were developed by fitting the log Pearson Type III distribution to the annual maximum flows with the expected probability adjustment. The following table contains the frequency-discharge relationships for the simulated regulated condition with the expected probability adjustment. Simulated regulated and simulated unregulated discharge-frequency relationships for the Wisconsin River at Wisconsin Dells are given on plate B-4. The regulated discharge-frequency curve shows a dip, or reverse curvature. This dip reflects the effect of regulation by the Wisconsin Valley Improvement Company for events greater than a 10-percent exceedence frequency. The regulated curve will tend to approach natural conditions for events on the order of 0.1-percent exceedence frequency.

BARABOO RIVER COINCIDENT WITH WISCONSIN RIVER

Because of its size, the Baraboo River watershed would be expected to significantly increase the frequency-discharge relationship on the Wisconsin River downstream of the confluence with the Baraboo River. Since the Wisconsin and Baraboo River USGS gages are a reasonable distance upstream of their confluence, a bivariate distribution was used for the analysis to develop a Wisconsin River frequency-discharge relationship downstream of the confluence. The Baraboo and Wisconsin Rivers recorded discharges considered in the analysis must be coincident since the sum of the discharges is the quantity of interest in the analysis. The period of record for which concurrent gaging records existed at the Baraboo and Wisconsin Dells gages was examined, and the maximum sum of discharges was found to occur almost without exception on the date of the Wisconsin River annual maximum. The samples used in the

SUMMARY OF FREQUENCY CURVES FOR SIMULATED, REGULATED ANNUAL MAXIMUM FLOWS FOR GAGING STATIONS ON THE WISCONSIN RIVER INCLUDING THE EXPECTED PROBABILITY ADJUSTMENT

Station Number	Station Name	Recurrence Interval, in Years				
		2	10	50	100	500
05391000	Wisconsin River at Rainbow Lake near Lake Tomahawk	2,000	2,800	3,500	3,700	4,300
05392000	Wisconsin River at Whirlpool Rapids near Rhinelander	3,200	4,600	5,800	6,300	7,400
05395000	Wisconsin River at Merrill	13,000	22,000	30,000	33,000	40,000
05398000	Wisconsin River at Rothschild	27,000	45,000	60,000	66,000	79,000
05400800	Wisconsin River at Wisconsin Rapids	32,000	54,000	72,000	78,000	91,000
05401500	Wisconsin River near Necedah	31,000	54,000	72,000	79,000	93,000
05404000	Wisconsin River near Wisconsin Dells	34,000	54,000	76,000	85,000	105,000
05406000	Wisconsin River at Prairie du Sac	36,000	63,000	82,000	88,000	103,000
05407000	Wisconsin River at Muscoda	35,000	59,000	76,000	83,000	95,000

bivariate analysis, therefore, consisted of the annual maximums of the Wisconsin River and the coincident flows on the Baraboo River. The frequency-discharge relationship for Baraboo River flows coincident with Wisconsin River annual peaks is shown on plate B-5. The average times determined for flood peaks on the Wisconsin and Baraboo Rivers to travel from their respective gage sites to the confluences differed by less than 1 day. Therefore, no lag time was assumed in determining the sample of Baraboo River flows coincident with Wisconsin River annual peaks.

The frequency-discharge relationship developed at Wisconsin Dells and the Baraboo coincident flow frequency-discharge relationship were found to closely approximate a log-normal distribution; therefore, the bivariate log-normal distribution was used. The frequency-discharge relationship at the Baraboo gage for Baraboo River annual maximums is given for the instantaneous peak and various other durations on plate B-6. These values are applicable at the Interstate 90/94 bridge which is near the mouth.

The correlation coefficient between the logarithms of Wisconsin River annual peak discharge and the logarithms of the coincident Baraboo River discharge was found to be approximately 0.6. For the assumed condition of levees being extended vertically to contain flood discharges, the frequency-discharge relationship just upstream of the Baraboo confluence is assumed to be the same as the frequency-discharge relationship at Wisconsin Dells. This is because the reduction in peak discharge due to channel storage has been determined to be negligible based on the results of modified puls routing through the reach from Wisconsin Dells to the Baraboo confluence.

The discharge downstream of the confluence can be treated as the sum of two random variables. The probability density function (p.d.f.) of the sum of the two random variables can be written as follows:

$$\text{p.d.f. of } u = x+y \text{ is}$$

$$f(u) = \int_0^{\infty} f(x, u-x)\,dx$$

In the case of the bivariate log-normal distribution, the p.d.f. may be written in terms of the discharges upstream of the confluence as follows:

$$f(x_1,x_2) = \frac{1}{2\pi\sigma_1\sigma_2 x_1 x_2\sqrt{1-\rho^2}} \cdot \exp(-0.5\ Q(x_1,x_2))$$

where

$$Q(x_1,x_2) = \frac{1}{1-\rho^2}\left[\frac{(\ln x_1-\mu_1)^2}{\sigma_1^{\ 2}} + \frac{(\ln x_2-\mu_2)^2}{\sigma_2^{\ 2}} - 2\rho\ \frac{(\ln x_1-\mu_1)(\ln x_2-\mu_2)}{\sigma_1\sigma_2}\right]$$

$$F(u) = \frac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}}\int_0^\infty \frac{1}{x_1(u-x_1)} \cdot \exp(-0.5\ Q(x_1,u-x_1))dx_1$$

Where x_1, x_2 = the upstream tributary discharges

u = the discharge downstream of the confluence

σ_1, σ_2 = the standard deviations of logarithms for the discharges of tributaries 1 and 2.

μ_1, μ_2 = the mean logarithms for the discharges of the tributaries 1 and 2.

ρ = the correlation coefficient between the logarithms of x_1 and x_2.

The above equation can be integrated numerically to yield the nonexceedence probability of a given value of u which in this case represents the logarithm of a given discharge downstream of the Baraboo confluence. By evaluating this equation for several values of u, a frequency-discharge relationship can be developed.

Assumed levee conditions 2 through 5 (see page B-34 for a discussion of levee conditions) result in significant lateral outflow away from the Wisconsin River and into storage areas; thus, on the Wisconsin River the frequency-discharge relationship just upstream of the Baraboo confluence will differ significantly from that at Wisconsin Dells. For levee conditions 2 through 5, the Wisconsin River discharges just upstream of the Baraboo confluence that are no longer log-normally distributed can be

related to the values at Wisconsin Dells which are still approximately log-normally distributed.

Frequency-discharge relationships downstream of the Baraboo River confluence for assumed existing levee conditions 1 through 5 are given on plates B-7 through B-9.

Frequency-discharge relationships downstream of the Duck Creek confluence were developed in a manner similar to that used for the frequency-discharge relationships downstream of the Baraboo confluence. Duck Creek, however, is not gaged and it was necessary to estimate its frequency-discharge relationship for discharges coincident with the annual peak discharges on the Wisconsin River. This was done by first developing a drainage area discharge relationship considering only annual peaks from regression on similar gaged watersheds in the region. Least squares estimates of B_0 and B_1 in the following equation resulted in a model to predict the discharge of a given return period as a function of drainage area alone for watersheds in this region.

$$Q_T = \beta_0 \ (D.A.)^{\beta_1}$$

Where Q_T = peak discharge (c.f.s.) for a flood of return period T.

$\log \beta_0$, β_1 = least squares coefficients in the logarithmically transformed linear model.

D.A. = drainage area (square miles)

The average value of B_1 for the different return period models was then used as an optimum "n exponent" in the drainage area comparison formula.

$$\frac{Q_1}{Q_2} = \left[\frac{(D.A._1)}{(D.A._2)}\right]^n$$

where Q_1, $D.A._1$ = the smaller discharge and drainage area.

Q_2, $D.A._2$ = the larger discharge and drainage area

The frequency-discharge relationship for Duck Creek discharge coincident with the Wisconsin River annual peaks was then predicted by "drainage area comparison" to the Baraboo coincident frequency-discharge relationship using the derived "n exponent". The correlation coefficient used between the logarithms of Wisconsin River annual peaks and the logarithms of the coincident Duck Creek discharges was reduced from the 0.6 for the Baraboo to 0.4. Based on engineering experience there is a tendency toward independence as tributary drainage area size decreases. Frequency-discharge relationships downstream of the Duck Creek confluence are given on plates B-7 through B-9. These curves show the minor impact of Duck Creek on Wisconsin River regardless of the flood frequency.

FOX RIVER DISCHARGE-FREQUENCY CURVES

The nearest gaging station downstream of Portage on the Fox River is at Berlin (drainage area = 1,430 square miles). The log Pearson Type III distribution with an adopted skew coefficient of -0.30 using the latest Water Resources Council guidelines for annual peaks at the Berlin gage is shown on plate B-10.

The Fox River annual peak discharge-frequency relationships at Portage were developed based on analyses of historical floods and use of Conger's regional regression equations (Estimating Magnitude and Frequency of Floods in Wisconsin, USGS Open File Report, 1971).

From analysis of the Berlin gage, the floods of 1881 and 1973 were found to have return periods of 40 years and 14 years, respectively. Analysis of other stream gages in the vicinity indicates that the 1973 flood event had a similar return period throughout the Fox River watershed. The 1881 flood is the largest flood of record at the Berlin gage and it appears likely that this flood would also have a similar return period throughout the Fox River basin. At the Berlin gage, only the peak stage was recorded for the 1881 flood event. However, from extension of the rating table at the Berlin gage by backwater computations, the peak discharge of approximately 11,000 cfs for the 1881 flood event could be estimated. Before October 27, 1954, the Berlin gage was located 0.3 mile upstream at

the same datum; however, the stream gradient is very slight and the rating curve would remain approximately the same.

High watermarks were available on the Fox River in Columbia County for the 1881 and 1973 flood events from which approximate discharges can be determined using the HEC-2 water surface profile.

As part of this study, the frequency-discharges were updated for the Fox River in accordance with the latest Water Resources Council guidelines. This was done to insure compatible discharges from Lake Winnebago upstream through a point upstream of the Wisconsin River interbasin flow.

Discharge-frequency relationships for the Columbia County Flood Insurance Study were determined by modeling several historical storms of known return period by use of HEC-1 and application of Conger's regional regression equation. A log-normal distribution was assumed when applying plotting positions to these historical events. These values from the Columbia County report were not altered for this analysis since no additional information is available which might alter the procedures or results of the prior study.

Statistical analyses on recorded annual peak discharges (81 years) at the Berlin gage were made. The results of this frequency analysis using the station skew of -0.3 with the expected probability adjustments are displayed in tabular form in the following table and on plate B-12. The -0.3 skew agrees with the regionalized skew adopted for the area.

Fox River at Berlin 4-0735, Final Results Frequency Curve

Peak Flows			Confidence Limits	
Computed	Expected Probability	Exceedence Probability	0.05 Limit	0.95 Limit
9,280.	9,560.	0.002	11000.	8110.
8,490.	8,690.	0.005	9930.	7480.
7,860.	8,010.	0.010	9120.	6980.
7,220.	7,330.	0.020	8280.	6460.
6,540.	6,610.	0.040	7420.	5910.
5,580.	5,620.	0.100	6210.	5100.
4,770.	4,790.	0.200	5230.	4400.
3,460.	3,460.	0.500	3730.	3220.
2,440.	2,430.	0.800	2650.	2230.
2,010.	1,990.	0.900	2210.	1800.
1,700.	1,680.	0.950	1890.	1500.
1,230.	1,190.	0.990	1410.	1040.

Frequency curve statistics:	Mean logarithm	3.5307
	Standard deviation	0.1735
	Computed skew	-0.3420
	Adopted skew	-0.3000

Statistics based on:	Historic events	0
	High outliers	0
	Low outliers	0
	Zero or missing	0
	Systematic years	81
	Total period (years)	81

The adopted discharges for the 2-, 5-, 10-, 50-, 100-, and 500-year events excluding the interbasin flow contribution are shown in the following table for locations throughout the Fox River. Frequency-discharge relationships including the interbasin flow contribution for the mouth of Neenan Creek and Berlin are given on plates B-11 and B-12.

Fox River Frequency-Discharge Relationships

Location	Drainage Area (square miles)	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)	Q_{500} (cfs)
Park Lake	53.8	930	1,120	1,250	1,580	1,700	2,000
Cross Section AF	68	820	990	1,120	1,420	1,550	1,850
Cross Section G	93.4	1,380	1,650	1,850	2,350	2,550	3,000
Montello Dam	369.9	1,870	2,290	2,550	3,250	3,500	4,150
USGS Gage at Berlin	1,430	3,800	4,790	5,620	7,330	8,010	9,560

FOX RIVER DISCHARGE-FREQUENCY CURVES COINCIDENT WITH WISCONSIN RIVER INTERBASIN FLOW

The Fox River discharges coincident with the annual peaks on the Wisconsin River were simulated using the drainage area ratio raised to the 0.6 power with a 5-day lag time between Berlin and Portage. The 5-day lag time was determined from the Fox River HEC-2 results in conjunction with comparison to the flood hydrographs on the Fox and Wisconsin Rivers. The analysis of the Fox River frequency-discharge relationship modified for the effect of Wisconsin River overflow was completed using concepts similar to those used in the bivariate analysis of discharge relationships downstream of river confluences. In this case, the random variable used in the bivariate distribution was the Wisconsin River annual peak discharges and the coincident Fox River discharges. The logarithms of both discharges were found to be approximately normally distributed. Wisconsin River discharges below the dis-

charge of "incipient spill" will have no effect on the Fox River discharges. Thus, the discharges downstream of the Neenah Creek confluence will be determined solely by the upstream Fox River discharge and Neenah Creek discharges when the Wisconsin River levels are below "incipient spill".

The bivariate normal distribution can be used to determine modified frequency-discharge relationships on the Fox River by constructing contours of equal Fox River discharge on two-way probability paper as shown on plate B-13 and the following table. The exceedence probability of a given Fox River discharge can be determined by numerically integrating the volume of the bivariate normal distribution above the equal discharge contours.

The discharge-frequency curves shown on plates B-11 and B-12 were modified to reflect the impacts of levee conditions 2 to 5. These curves are considered valid at the Neenah Creek location (cross section AF) because the proximity to Portage reduces the impacts of flow routing. The discharge-frequency curve at Berlin was not modified to reflect these levee conditions as detailed Fox River routings of the modified flows were not performed.

BARABOO RIVER DISCHARGE-FREQUENCY CURVE

The Baraboo River has drainage areas of 609 square miles at its gaged location approximately 16.4 miles upstream of its mouth and 629 square miles at the Interstate 90/94 bridge located in the flat land adjacent to the Wisconsin River, about 7.58 miles upstream of its mouth. The period of record at Baraboo is 1913-22 and 1942-76 for a total length of 45 years. Because of the relatively small local contributing area downstream of the gage, flows were not drainage area adjusted at the mouth.

COMPUTATIONS FOR DETERMINING PROBABILITY PLOTTING POINTS
FOR EQUAL DISCHARGE CONTOURS OF FOX RIVER DISCHARGE
LEVEES OVERTOPPED BUT NOT BREACHED - CONDITION 2

Equal Discharge Contour Value on Fox River	Wisconsin River Flow at Wisconsin Dells (cfs)	Exceedance Probability	Wisconsin River Overflow to Big Slough (cfs)	Exceedance Probability	Upstream Fox River and Neenah Creek Flow (cfs)	Exceedance Probability
500	78,000	.0165	0	≥.0165	500	.842
	79,500	.015	200	.0150	300	.970
	80,000	.014	300	.0140	200	.995
	80,500	.0135	500	.0135	0	~1.0
1,000	78,000	.0165	0	≥.0165	1,000	.432
	79,500	.015	200	.0150	800	.580
	80,000	.014	400	.0140	600	.760
	81,000	.013	600	.0130	400	.918
	82,000	.0122	800	.0122	200	.995
	82,300	.0119	1,000	.0119	0	~1.0
2,000	78,000	.0165	0	≥.0165	2,000	.089
	80,500	.0135	500	.0135	1,500	.195
	82,300	.0119	1,000	.0119	1,000	.432
	82,500	.0115	1,500	.0115	500	.842
	83,500	.0110	2,000	.0110	0	~1.0
4,000	78,000	.0165	0	≥.0165	4,000	.0058
	82,200	.0120	1,000	.0120	3,000	.021
	83,500	.0110	2,000	.0110	2,000	.089
	84,000	.0104	3,000	.0104	1,000	.432
	85,000	.0100	4,000	.0100	0	~1.0

COMPUTATIONS FOR DETERMINING PROBABILITY PLOTTING POINTS
FOR EQUAL DISCHARGE CONTOURS OF FOX RIVER DISCHARGE
LEVEES OVERTOPPED BUT NOT BREACHED CONDITION 2

Equal Discharge Contour Value on Fox River	Wisconsin River Flow at Wisconsin Dells (cfs)	Exceedance Probability	Wisconsin River Overflow to Big Slough (cfs)	Exceedance Probability	Upstream Fox River and Neenah Creek Flow (cfs)	Exceedance Probability
8,000	78,000	.0165	0	≥.0165	8,000	.0001
	82,300	.0119	1,000	.0119	7,000	.00026
	83,500	.0110	2,000	.0110	6,000	.00067
	85,000	.0100	4,000	.0100	4,000	.0058
	86,400	.0087	6,000	.0087	2,000	.089
	88,000	.0075	7,000	.0075	1,000	.432
	90,000	.0065	8,000	.0065	0	~1.0
20,000	78,000	.0165	0	≥.0165	20,000	.0001
	96,500	.0038	12,000	.0038	8,000	.0001
	98,200	.0034	13,000	.0034	7,000	.00026
	100,000	.0029	14,000	.0029	6,000	.00067
	103,000	.0023	16,000	.0023	4,000	.0058
	107,000	.0018	18,000	.0018	2,000	.089
	108,000	.0016	19,000	.0016	1,000	.432
	110,000	.0014	20,000	.0014	0	~1.0

STANDARD PROJECT FLOOD HYDROGRAPHS FOR THE WISCONSIN AND BARABOO RIVERS

Drainage areas and discharge records for the Baraboo River at Baraboo and the Wisconsin River at Wisconsin Dells were obtained from water resources data. The precipitation data were obtained from hourly precipitation data. Rain gages and the associated Thiessen polygons developed to show rainfall contributions over the two watersheds are located on plates B-14 and B-15. The summary of the rain data used for each event is shown in the following tables.

RAINFALL EXCESS SUMMARY

Wisconsin River - Total Basin	Time - Days 1	2	3	4	5	6	7	8	Total	ɸ-index (in/hr)	Initial Loss range (in)
September 1959											
Total	.99	.32	1.01	0	0	1.04	1.69	.47	5.52		
Excess	0	0	.09	0	0	.12	.76	0	.97	.04	.07-1.31
June 1969											
Total	.73	.09	.01	1.05	1.75	.02	.04	.38	4.97		
Excess	.10	0	0	.10	.70	0	0	0	.90	.04	.63
September 1972											
Total	.21	2.57	.17	0	.98				3.93		
Excess	0	1.11	0	0	0				1.11	.06	1.68
June 1969											
Total	.81	.10	.01	1.08	1.90	.03	.07	.57	4.57		
Excess		.10		.10	.86				1.06	.06	.81
September 1972											
Total	.32	2.67	.25	0	1.19				4.43		
Excess	0	1.33	0	0	0				1.33	.05	1.66

Baraboo River	Time - Hours 12	24	36	48	Total	ɸ-index (in/hr)	Initial Loss range (in)
September 1959							
Total	.96	.87	1.03	.50	3.36		
Excess	0	0	.26	0	.26	.06	1.06
June 1968 (1)							
Total	2.30				5.65		
Excess	.92				.92	.11	1.38
September 1972							
Total	1.54	.57	.47	1.12	3.70		
Excess	.62	0	0	.21	.83	.08	.92
April 1975							
Total	1.10	.43	.98		2.51		
Excess	.34	0	.22		.56	.06	.76

Notes: (1) Twelve periods of rainfall are not tabulated as they are insignificant.

RAINFALL SUMMARY

Gages Contributing to Wisconsin River Upstream of Wisconsin Dells

Gage	Percent contributing to Total basin	Percent contributing to Partial basin	Total rainfall (inches) for event 1959	1969	1972
Babcock	8	11	4.78	6.77	3.15
Coddington	6	9	3.65	3.79	5.71
Eau Pleine Reservoir	7	11	6.40	5.22	5.05
Friendship	10	15	4.29	3.87	3.56
Marshfield	6	9	5.89	4.30	5.50
Medford	6	9	4.97	3.35	4.20
Merrill	13	14	7.24	4.15	4.90
Phelps	3		8.63	2.01	2.93
Portage	1	2	1.65	4.63	1.56
Prentice	2		4.49	2.90	3.20
Rainbow Reservoir	7		6.52	2.12	3.17
Rice Reservoir	10		3.85	2.67	2.79
Three Lakes	6		6.20	N.O.(1)	2.50
Tomah	6	8	5.05	4.80	N.O.(1)
Wausau	9	12	6.28	4.83	N.O.(1)
Total basin			5.52	4.97	3.93
Partial basin			5.38	4.57	4.43

Gages Contributing to Baraboo River Upstream of Baraboo

Gage	Percent contributing	Total rainfall (inches) for event 1959	1968	1972	1975
Hillsboro	76	3.35	5.86	4.37	2.64
Tomah	24	3.38	4.97	1.56	2.20
Total		3.36	5.65	3.70	2.51

(1) N.O. - Not Operating

Wisconsin River

Two standard project flood hydrographs were computed for the Wisconsin River at Wisconsin Dells. The first method used the total watershed while the second method, using a partial basin, did not consider the watershed upstream of Merrill, Wisconsin. Unit hydrographs were developed in a manner similar to that used for the Baraboo River. The events selected were: September, October 1959; June, July 1969; and September, October 1972. Only flood runoff events occurring after June 15 were considered since the reservoirs on the river system are maintained at a nearly full level, thus minimizing storage effects from this source. There are many natural lakes above Merrill, in addition to the tributary storage lakes. These historical flood hydrographs for Wisconsin Dells and Merrill are shown on plates B-16 through B-18.

Due to the size of the basin, a unit storm duration of 24 hours was selected. Base flow was separated in a manner similar to that used for the Baraboo River except for the 1973 event. This event had a comparatively high initial discharge (8,000 cfs). Therefore, a constant base flow of 8,000 cfs was used. The volume of runoff and Phi-index were computed for each event. The method previously used to compute the unit hydrograph was stable only for the 1972 event. The unit graphs for the other two events were computed by iteratively combining an assumed unit graph until the computed runoff hydrograph closely matched the observed runoff hydrograph. Again, the composite unit hydrograph (plate B-19) was computed by averaging the peak and time to peak and adjusted to yield the 1 inch of runoff.

The standard project storm was computed using the method for small drainage basins as shown in EM 1110-2-1411 because data for large basins are not presently available. The standard project flood index rain is 10.4 inches. The drainage area up to Merrill was delineated on a 1:500,000 scale topographic map and overlayed with the isohyetal pattern map on plate 12 of EM 1110-2-1411. The 80-percent contour was extended

and the 70-percent contour was added visually. The remaining 2,760 square mile drainage area was assumed to be divided equally between the 60-percent and 50-percent contours. The derived areal reduction factor applied to the index rain is 0.68.

The initial loss and Phi-index were determined as noted previously. The Phi-index used was 0.06 inch per hour, and the initial loss was 0.5 inch.

The standard project storm excess rainfall was combined with the unit graph to obtain the standard project flood runoff hydrograph. A base of 6,700 cfs, the average flow for the period of record, was added to obtain the total standard project flood hydrograph, shown on plate B-20. The standard project flood peak is 178,000 cfs.

The standard project flood for the portion of the Wisconsin River downstream of Merrill was also computed. The Wisconsin River watershed is heavily regulated upstream of Merrill. The applicability of the basin upstream of Merrill to unit hydrograph theory is, at best, questionable.

Two events were selected for this unit hydrograph: June, July 1969 and September, October 1970. The 1959 event was not used because the rainfall on the lower portion of the watershed was considerably lower than the basin average.

The hydrographs at Merrill were lagged 2 days and plotted with the hydrographs at Wisconsin Dells as shown on plates B-17 and B-18 to determine the flow entering the stream downstream from Merrill. The same base flow used for the total basin was used in this analysis. The volume of runoff and Phi-index were computed for each event. Again, the 24-hour unit hydrographs were computed directly for the 1972 event and iteratively for the 1969 event. A composite unit hydrograph was computed as described previously. This is shown on plate B-21.

The standard project storm was computed using the method previously described. The standard project storm index rain is 10.4 inches; the areal reduction factor is 0.78. The same initial loss and Phi-index were used. A base flow of 6,700 cfs was added to the standard project storm hyetograph to get the total standard project flood hydrograph, shown on plate B-22. The standard project flood peak is 145,000 cfs. It is recommended that this standard project flood be used rather than the one for the total basin for the following reasons: (1) the degree of regulation upstream of Merrill (natural and man-made) and (2) watershed sizes are not readily applicable to unit hydrograph theory. Unit hydrograph theory would be less applicable to 8,090 square miles than to 5,330 square miles. The difference in water surface elevation in the Portage area between 145,000 and 178,000 cfs is expected to be small, for existing conditions, because significant levee overtopping occurs.

The above analysis was not based on the U.S. Geological Survey streamflow model since that model was developed primarily for use in analyzing historical records to develop regulated and unregulated discharge-frequency curves. For that model, the loss rates and routing criteria are specific to the historical record. The model does not feature the generalized coefficients and loss rates necessary in a standard project flood determination.

Baraboo River

Four events were selected from the gage records (September, October 1959; June, July 1968; September, October 1972; and April, May 1975) for developing a unit hydrograph to compute a standard project flood for the Baraboo River at Baraboo. No snowmelt related events were considered as standard project flood computations do not consider snowmelt. Rainfall for each event studied on the Wisconsin and Baraboo Rivers was tabulated using gaging stations shown in the table on page B-27. The historical flood hydrographs are plotted on plates B-23 through B-26.

For unit hydrograph computation, base flow was assumed to equal the discharge at the start of the hydrograph. It was then decreased somewhat until the hydrograph peaked based on a review of historical data. Then a rising limb was assumed such that the time from hydrograph peak to the end of surface runoff would be 4 to 5 days. The volume of surface runoff under the hydrograph was then computed. A uniform loss rate (Phi-index) was estimated for each event to yield the proper volume of rainfall excess. Unit hydrographs were determined for each historic event.

No synthetic parameters such as Clarks's Tc and R or Snyder's Ct and CP were used. A 6-hour unit storm duration yielded unstable results for two events; therefore, a unit storm duration of 12 hours was used. A composite unit hydrograph was determined by an arithmetic average of the peak discharges, times to peak, and base times for the four computed unit hydrographs. This method locates the unit hydrograph peak and gives a time base. The unit graph is then sketched between arithmetic points to yield a 1-inch volume. This procedure is recommended over an arithmetic average of all ordinates as it gives a higher peak. Plate B-27 shows the four individual unit graphs and the composite obtained by averaging all ordinates. The recommended composite unit hydrograph is shown on plate B-28.

The standard project storm hyetograph with an index rainfall of 10.4 inches was computed according to procedures outlined in EM 1110-2-1411. The drainage area was delineated on a 1:500,000 scale topographic map and overlayed with the isohyetal pattern on plate 12 of EM 1110-2-1411 to determine the areal reduction factor to be applied to the index rainfall. The areal factor was determined to be 1.06.

The initial loss and Phi-index to be applied to the standard project storm were determined by analyzing the historical events used to develop the unit hydrograph. Based on data shown in the table on page B-3, a Phi-index of 0.06 inch per hour and initial loss of 0.5 inch were selected. The standard project storm rainfall excess hyetograph was

convoluted with the unit hydrograph to obtain the standard project flood runoff hydrograph. A base flow of 370 cfs, the average flow for the period of record, was added to obtain the total standard project flood hydrograph for the Baraboo River at Baraboo as shown on plate B-29. The standard project flood hydrograph peak discharge is 23,000 cfs.

Fox River above Ward 1

An analysis to determine the standard project flood peak discharge for the runoff from the Fox River above Ward 1, without consideration of Wisconsin River overflows, was completed without using EM 1110-2-1411. The storage available at Park Lake Dam and Fox River Swamp have effected a significant attenuation of flood flows. This has resulted in a discharge-frequency curve of a relatively flat slope. Therefore, even though the standard project flood peak discharge is not significantly larger in magnitude than the 0.2-percent exceedence frequency (500-year flood) it is conservatively high in terms of frequency. In this case, the standard project flood peak discharge is conservatively estimated to be 2,500 cfs which is a 0.01 percent exceedence frequency event. Since the corresponding elevation for this discharge (elevation 784.2, from plate C-86) is equivalent to the zero damage elevation in Ward 1, a more detailed evaluation was not deemed warranted because it would most certainly result in a lower discharge value. Appendix C discusses the effect at Ward 1 from Wisconsin River overflows having a higher resultant maximum elevation than Fox River runoff alone.

IMPACT OF ALTERNATIVES ON DISCHARGE AND ELEVATION FREQUENCY

GENERAL

Discharge-frequency curves and elevation-frequency information (see The Selected Plan Section of the Hydraulics appendix which identifies the corresponding stage data for selected frequencies) were developed to show

the impact of structural alternatives at selected locations on the Wisconsin River main stem. The structural alternatives analyzed for this report are:

a. Raise and widen the Portage levee.

b. Raise and widen the Portage levee plus build a new Lewiston levee to prevent overflow to the Fox River.

The impact of these alternatives was analyzed at two locations on the Wisconsin River, at cross section AD (just downstream of the Portage levee) and below the mouth of the Baraboo River.

DISCUSSION OF ALTERNATIVES

The two structural alternatives under consideration coupled with the existence of the Portage, Lewiston, and Caledonia levees has raised several possible levee failure modes to be analyzed. At cross section AD, as well as below the mouth of the Baraboo River on the Wisconsin River, discharge-frequency curves were drawn to reflect engineering judgment to make maximum use of existing data and computer models. The results are plotted on plates B-30 through B-33 to represent a reasonable estimate of the impact of each alternative on the discharge-frequency curve at the two main stem locations. The failure modes are summarized in the upper left corner of plates B-30 through B-33 for each alternative at each location. The following levee conditions have been analyzed in detail using HEC-1 routings and HEC-2 water surface profile computer programs.

1. All flow is confined within the levees (levees hold).

2. The levees are overtopped but do not breach or fail.

3. No levees (total levee failure).

4. Complete failure of the Caledonia and Lewiston levees with the Portage levee holding.

5. Complete failure of the Portage levee with the Caledonia and Lewiston levees holding.

Minor modifications of the existing computer runs were used to develop a reasonable representation of each failure mode in relation to the existing condition. Because of the complexity of the study area, a brief description of the technique used to modify the discharge-frequency curves is presented below. Derivation of discharge-frequency curves below the mouth of the Baraboo River for each alternative involves consideration of the coincidental discharges from the Baraboo River being added to the Wisconsin River peak discharge at Section AD.

This addition of flow depends on the levee condition. For levee conditions 3 and 4, the Wisconsin River floodway encompasses the Baraboo River up to the Interstate 90 - State Trunk Highway 33 interchange. This is located between cross sections AS and AT, where coincidental Baraboo River flows are combined with Wisconsin River flows for these levee conditions. Therefore, discharge-frequency curves at section AD did not have to be modified below the mouth of the Baraboo River if the analysis used a modified version of levee condition 3 or 4. For levee conditions 1, 2 and 5, or modifications thereof, this coincidental Baraboo River flow was considered and the section AD curves were so modified.

To make plates B-30 through B-33 more understandable, a brief description of analysis techniques and assumptions made based upon a review of existing profiles is presented below. A more detailed description of the profiles can be found in Appendix C, Selected Plan Section. Due to the large number of curves presented for each alternative, the following table shows the plotted discharges for clarification.

a. Discharge-Frequency Curves for Wisconsin River at Section AD

(1) Alternative A - Raise and Widen the Portage Levee

(a) Failure of the Caledonia levee with Lewiston levee holding - Analyzed as a modification of levee condition 3. As part of the levee condition 3 analysis, several HEC-2 runs were made, including 10,000 cfs increments up to 100,000 cfs, the 1-percent, and the standard project flood. On the Lewiston side, U.S. Highway 16 or the railroad embankment was used as a floodway limit instead of the existing levees. This was considered acceptable since the increase in conveyance would not significantly affect the 1-percent, 0.2-percent, and standard project flood water surface profiles. Failure of the Caledonia levee would result in a revised flow area bounded by the Interstate 94 embankment. An effect of storage is shown at the 0.2-percent peak.

(b) Failure of the Lewiston and Caledonia levees - Equivalent to levee condition 4, as the effects at the Portage levee would be minimal.

(c) Overtopping of the Lewiston and Caledonia levees - Equivalent to levee condition 2, as the effects at the Portage levee would be minimal.

(d) Failure of the Lewiston levee, Caledonia levee holds - Analyzed as a modification of levee condition 2.

(2) Alternative B - Raise and Widen the Portage Levee plus a New Lewiston Levee to Prevent Fox River Overflows

(a) Failure of the Caledonia levee - Analyzed as a modification of levee condition 3, as in (1)(a) above.

(b) Overtopping of the Caledonia levee - Analyzed as a modification of levee condition 2. The water surface profiles and flow into the Caledonia reservoir are controlled by the height of the Caledonia levees.

Peak discharges at section AD at selected exceedence frequencies

LEVEE CONDITION	Peak discharge (cfs) 10% Event	4% Event	2% Event	1% Event	0.2% Event
Section AD with no impact analysis	55,000	67,000	78,500	86,000	112,000
1. Alternative A:					
a. Failure of the Caledonia levee with Lewiston levee holding	-	-	-	86,000	105,000
b. Failure of Lewiston and Caledonia levees	-	-	76,000	83,000	95,000
c. Overtop Lewiston and Caledonia levees	-	65,000	71,000	76,000	80,000
d. Lewiston levee fails, Caledonia holds	-	64,000	69,000	73,000	76,000
2. Alternative B:					
a. Caledonia levee fails	-	-	-	86,000	105,000
b. Caledonia overtopped, but no failure	-	65,000	71,500	77,000	86,000

b. <u>Discharge-Frequency Curves for the Wisconsin River below the Mouth of the Baraboo River</u>. - Tabulated discharges for each alternative are presented in the following table.

(1) <u>Alternative A - Raise and Widen the Portage Levee</u>

(a) Failure of the Caledonia levee with the Lewiston levee holding - No Baraboo River coincidental flows were added as this is a modification of levee condition 3.

(b) Failure of the Lewiston and Caledonia levees - No Baraboo River coincidental flows were added as this is equivalent to levee condition 4. It is noted here, but is true for succeeding alternatives, that the modifications due to alternatives do not "blend in" to the unmodified curve at section AD and below the Baraboo River at exactly the same point because the unmodified curves are of slightly different magnitude at each location.

(c) Overtopping of the Lewiston and Caledonia levees - Baraboo River coincidental flows were added as this is equivalent to levee condition 2.

(d) Failure of the Lewiston levee, Caledonia levee holds - Baraboo River coincidental flows were added, as this was analyzed as a modification of levee condition 2.

(2) <u>Alternative B - Raise and Widen the Portage Levee plus a New Lewiston Levee to Prevent Fox River Overflows</u>

(a)Failure of the Caledonia levee - Baraboo River coincidental flows were not added, as this was analyzed as a modification of levee condition 3.

(b) Overtopping of the Caledonia levee - Baraboo River coincidental flows were added, as this was analyzed as a modification of levee condition 2.

Peak Discharges for Wisconsin River Below Mouth of Baraboo River At Selected Exceedence Frequencies

LEVEE CONDITION	Peak discharge (cfs) 10% Event	4% Event	2% Event	1% Event	0.2% Event
Wisconsin River below Baraboo River with no impact analysis	55,500	69,000	79,000	89,000	114,000
1. Alternative A:					
a. Failure of the Caledonia levee with Lewiston levee holding	-	-	-	-	105,000
b. Failure of Lewiston and Caledonia levees	-	67,000	76,000	83,000	95,000
c. Overtop Lewiston and Caledonia levees	-	67,000	74,000	80,000	88,000
d. Lewiston levee fails, Caledonia holds	-	67,000	73,000	78,000	84,000
2. Alternative B:					
a. Caledonia levee fails	-	68,000	77,000	86,000	105,000
b. Caledonia overtopped, but no failure	-	68,000	76,000	82,000	95,000

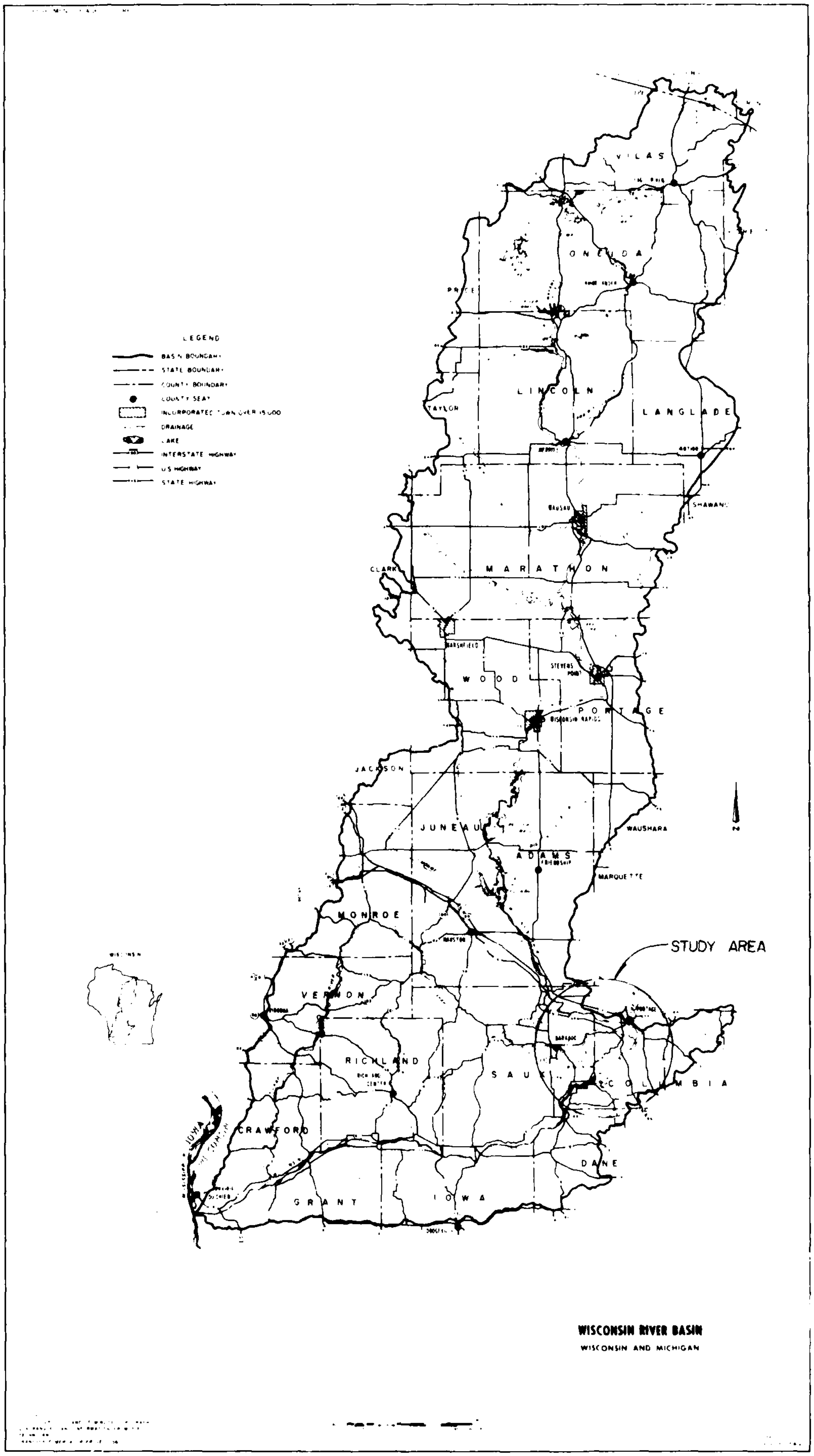

LEGEND
BASIN BOUNDARY
STATE BOUNDARY
COUNTY BOUNDARY
COUNTY SEAT
INCORPORATED TOWN OVER 15,000
DRAINAGE
LAKE
INTERSTATE HIGHWAY
U.S. HIGHWAY
STATE HIGHWAY
VILAS
ONEIDA
PRICE
LINCOLN
TAYLOR
LANGLADE
SHAWANO
WAUSAU
MARATHON
CLARK
MARSHFIELD
STEVENS POINT
WOOD
PORTAGE
WISCONSIN RAPIDS
JACKSON
JUNEAU
ADAMS
WAUSHARA
MARQUETTE
MONROE
STUDY AREA
VERNON
RICHLAND
SAUK
COLUMBIA
CRAWFORD
DANE
GRANT
IOWA
WISCONSIN RIVER BASIN
WISCONSIN AND MICHIGAN

PLATE B-1

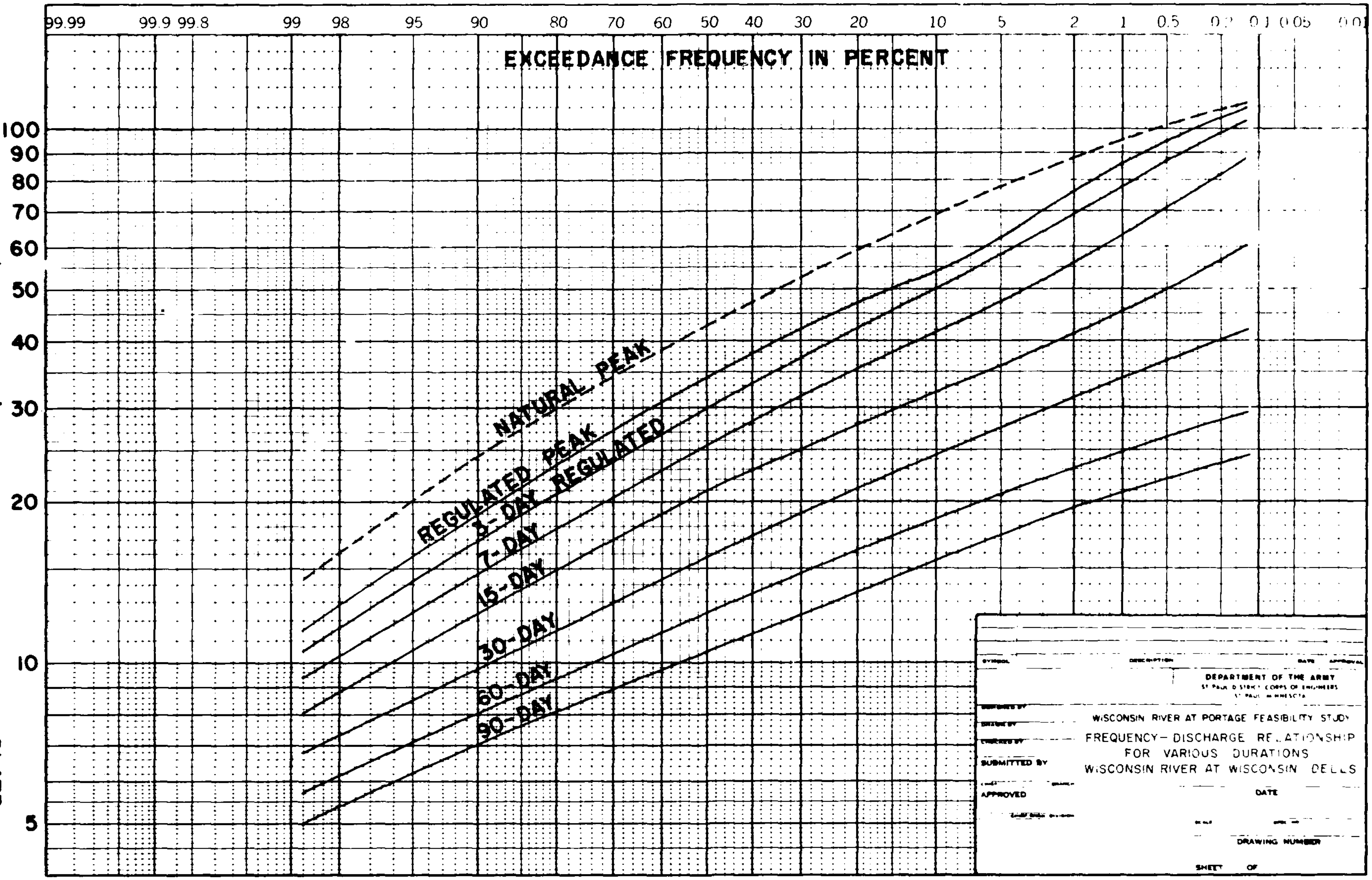

EXCEEDANCE FREQUENCY IN PERCENT
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.1
0.05
DISCHARGE (CFS X 1000)
100
90
80
70
60
50
40
30
20
10
5
NATURAL PEAK
REGULATED PEAK
3-DAY REGULATED
7-DAY
15-DAY
30-DAY
60-DAY
90-DAY
SYMBOL
DESCRIPTION
DATE
APPROVAL
DEPARTMENT OF THE ARMY
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
APPROVED
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FREQUENCY- DISCHARGE RELATIONSHIP
FOR VARIOUS DURATIONS
WISCONSIN RIVER AT WISCONSIN DELLS
DATE
DRAWING NUMBER
SHEET
OF

PLATE B-2

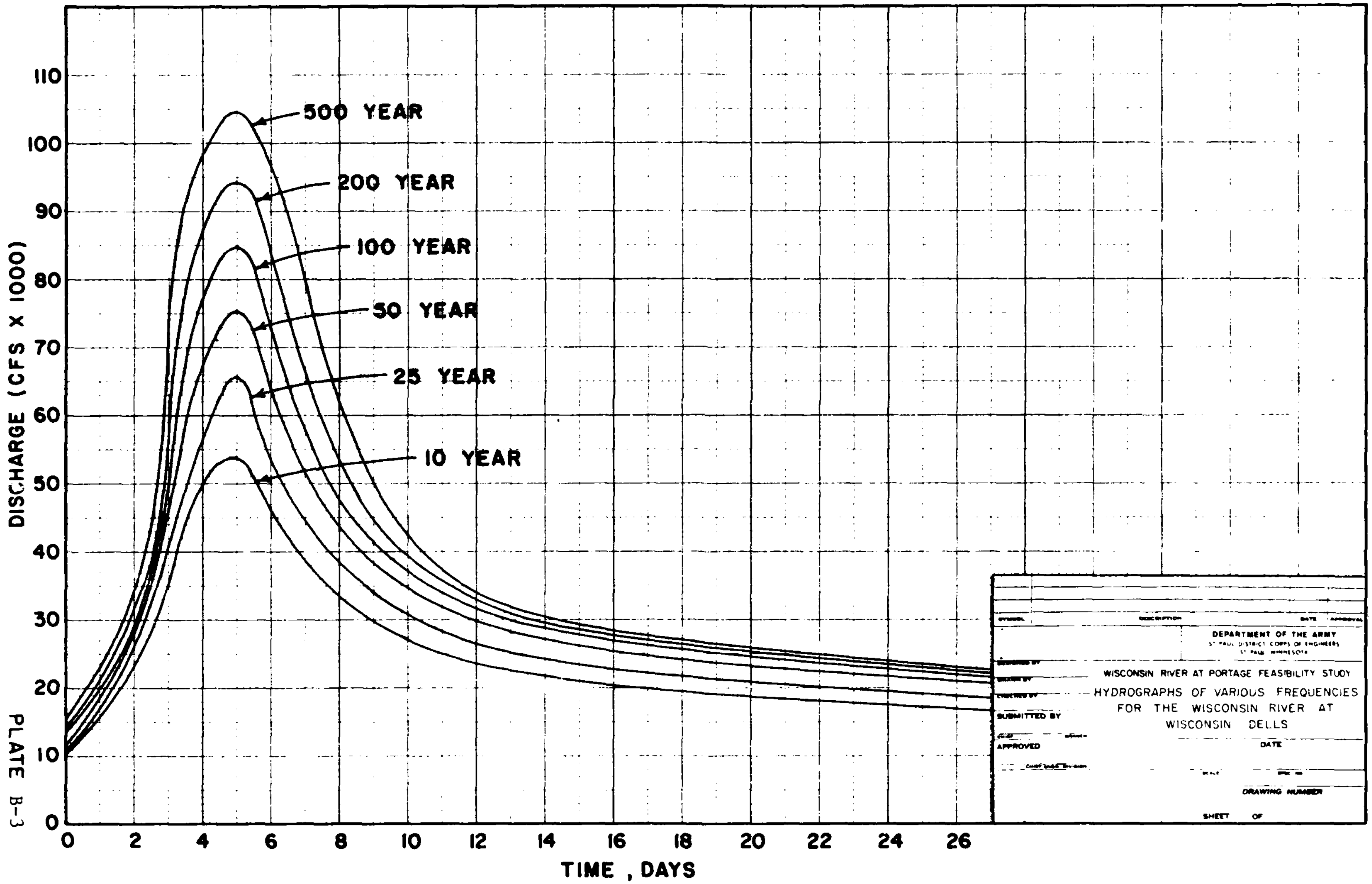
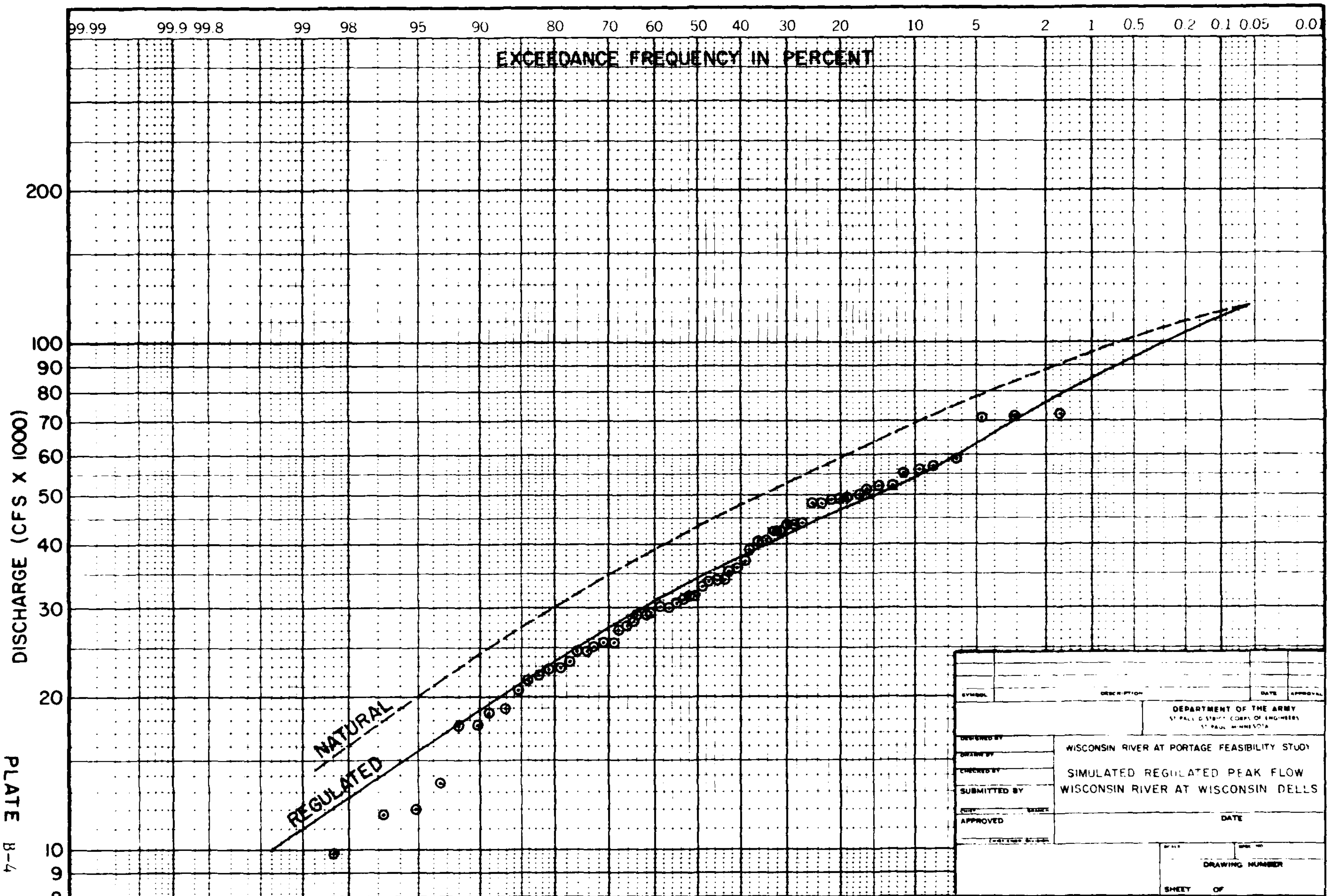

500 YEAR
200 YEAR
100 YEAR
50 YEAR
25 YEAR
10 YEAR
DISCHARGE (CFS X 1000)
0
10
20
30
40
50
60
70
80
90
100
110
TIME , DAYS
0
2
4
6
8
10
12
14
16
18
20
22
24
26
SUBMITTED BY
APPROVED
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
HYDROGRAPHS OF VARIOUS FREQUENCIES
FOR THE WISCONSIN RIVER AT
WISCONSIN DELLS
DATE
DRAWING NUMBER
SHEET
OF

PLATE B-3


EXCEEDANCE FREQUENCY IN PERCENT
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
DISCHARGE (CFS X 1000)
200
100
90
80
70
60
50
40
30
20
10
9
8
NATURAL
REGULATED
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
SIMULATED REGULATED PEAK FLOW
WISCONSIN RIVER AT WISCONSIN DELLS
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET
OF

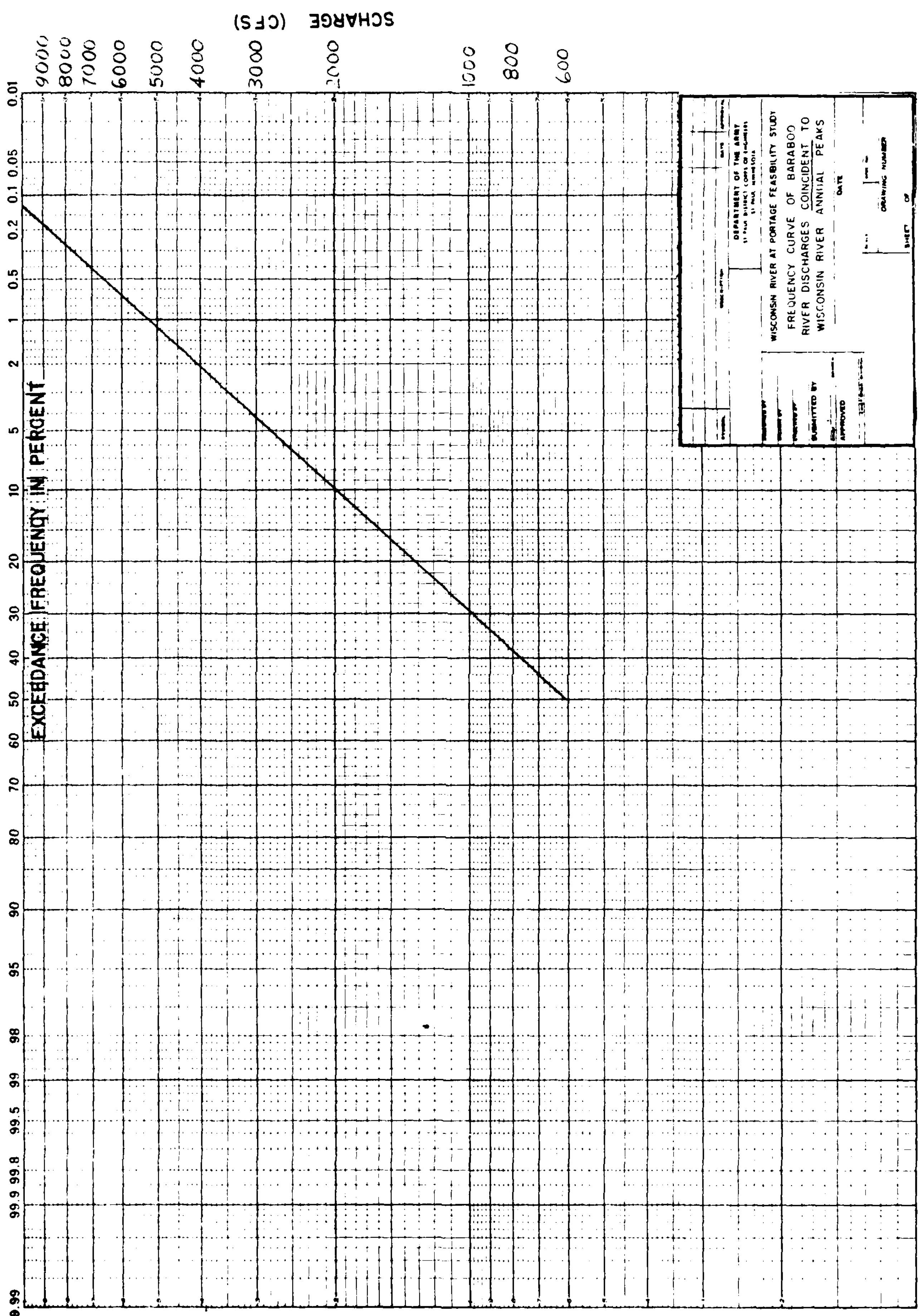
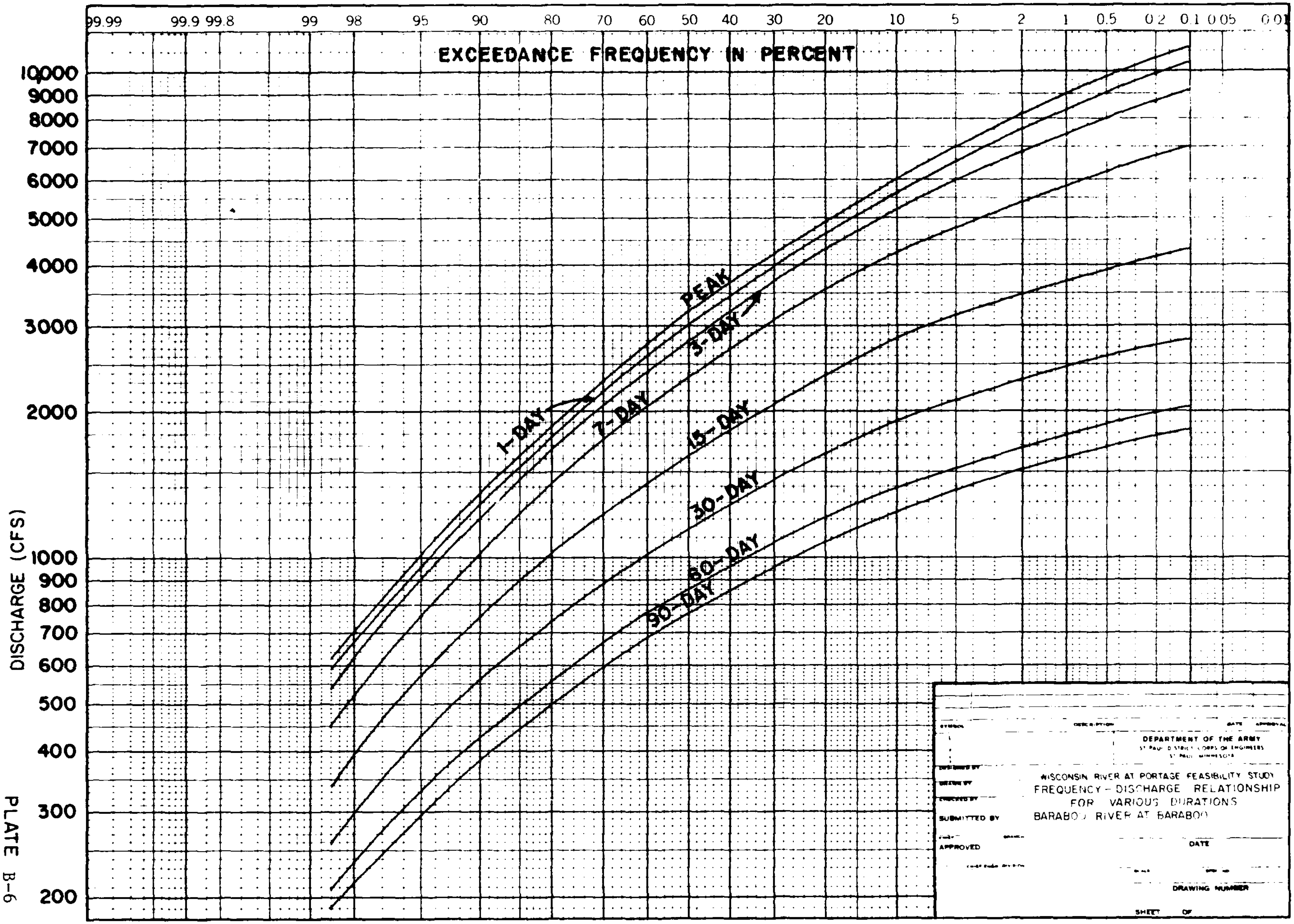
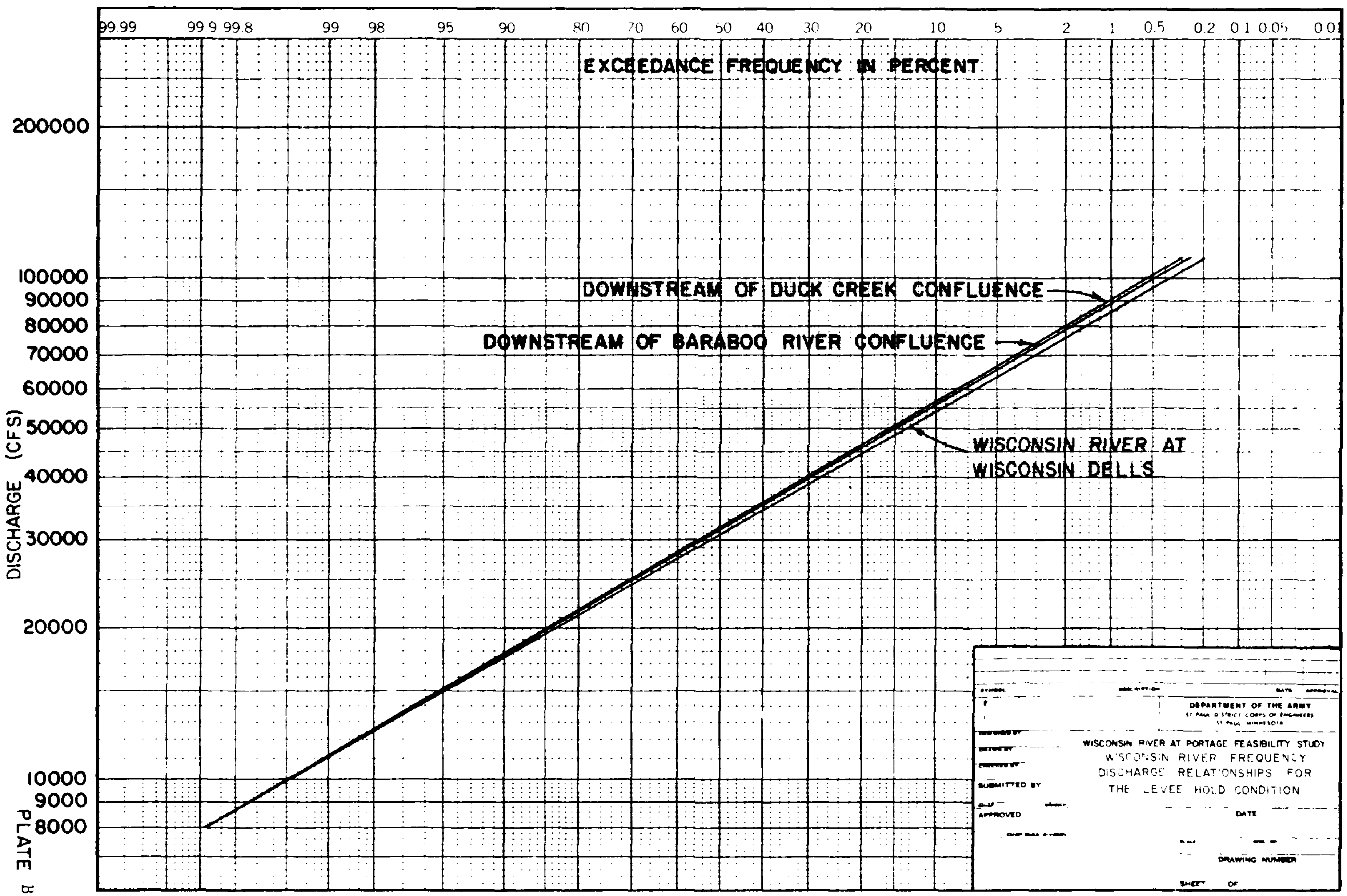

SCHARGE (CFS)
9000
8000
7000
6000
5000
4000
3000
2000
1000
800
600
EXCEEDANCE FREQUENCY IN PERCENT
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASBILITY STUDY
FREQUENCY CURVE OF BARABOO
RIVER DISCHARGES COINCIDENT TO
WISCONSIN RIVER ANNUAL PEAKS
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET
OF

PLATE B-5



EXCEEDANCE FREQUENCY IN PERCENT
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
DISCHARGE (CFS)
10,000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
PEAK
3-DAY
1-DAY
7-DAY
15-DAY
30-DAY
60-DAY
90-DAY
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FREQUENCY - DISCHARGE RELATIONSHIP
FOR VARIOUS DURATIONS
BARABOO RIVER AT BARABOO
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET
OF

PLATE B-6


EXCEEDANCE FREQUENCY IN PERCENT
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
DISCHARGE (CFS)
200000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
9000
8000
DOWNSTREAM OF DUCK CREEK CONFLUENCE
DOWNSTREAM OF BARABOO RIVER CONFLUENCE
WISCONSIN RIVER AT WISCONSIN DELLS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
WISCONSIN RIVER FREQUENCY
DISCHARGE RELATIONSHIPS FOR
THE LEVEE HOLD CONDITION
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

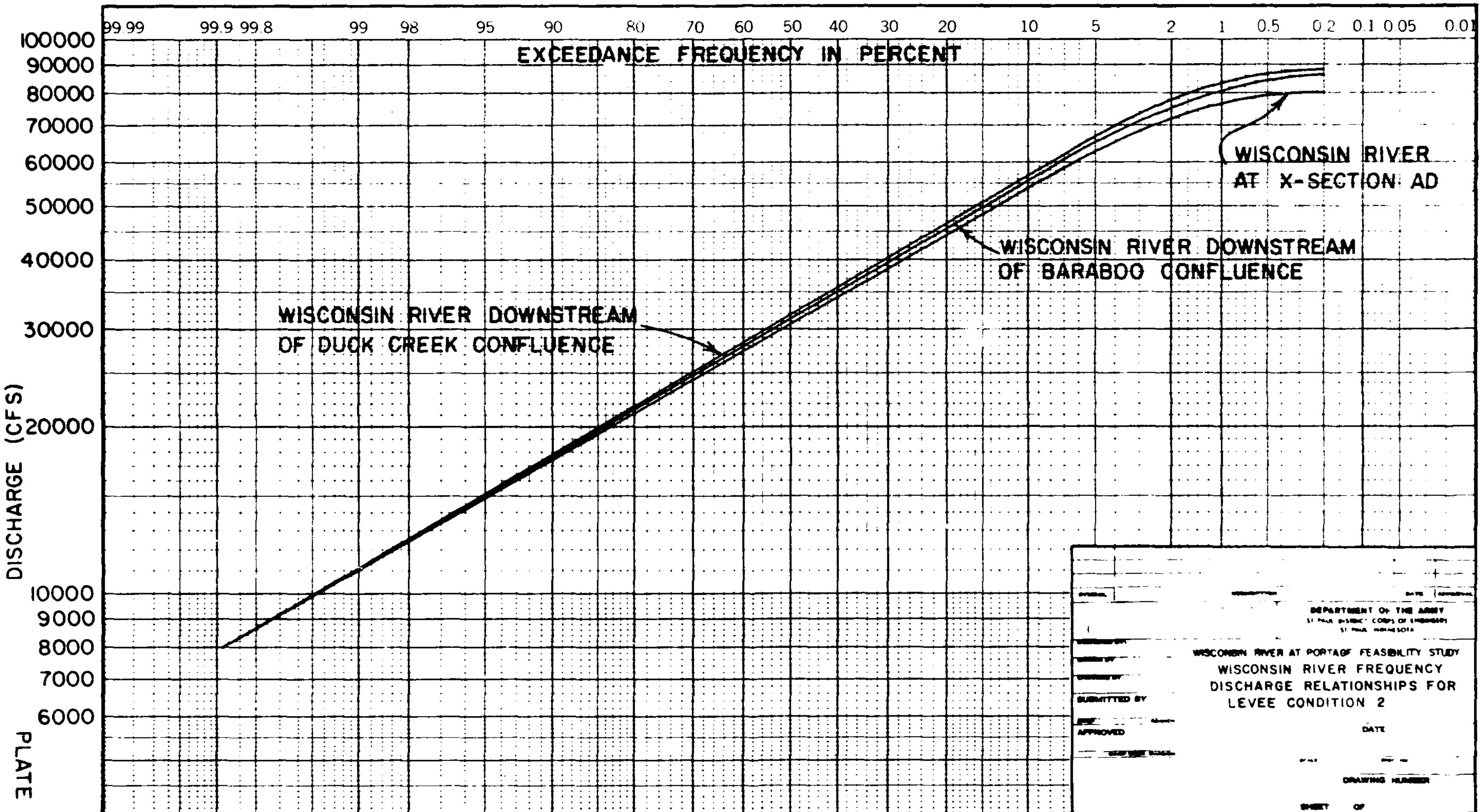
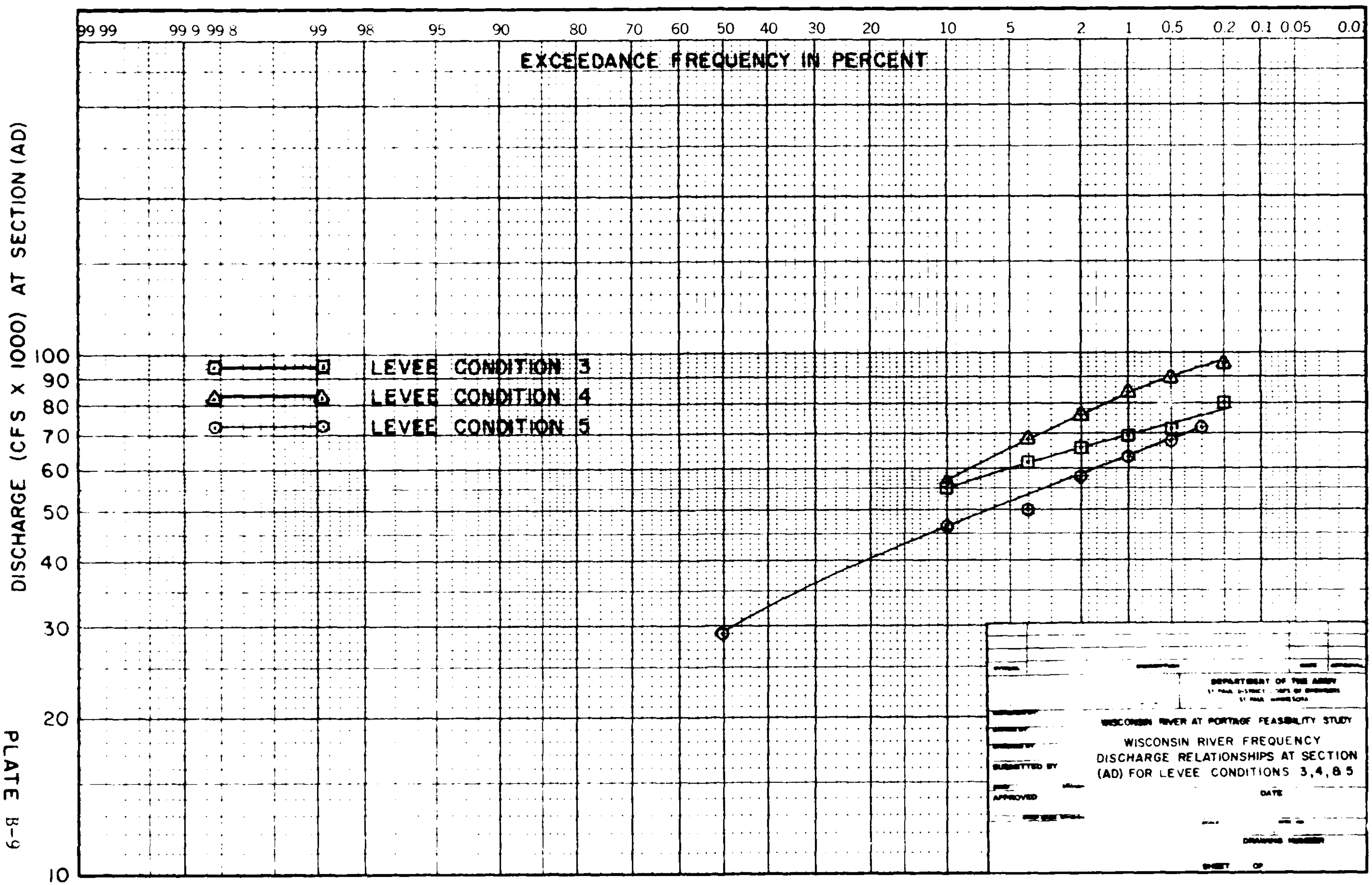
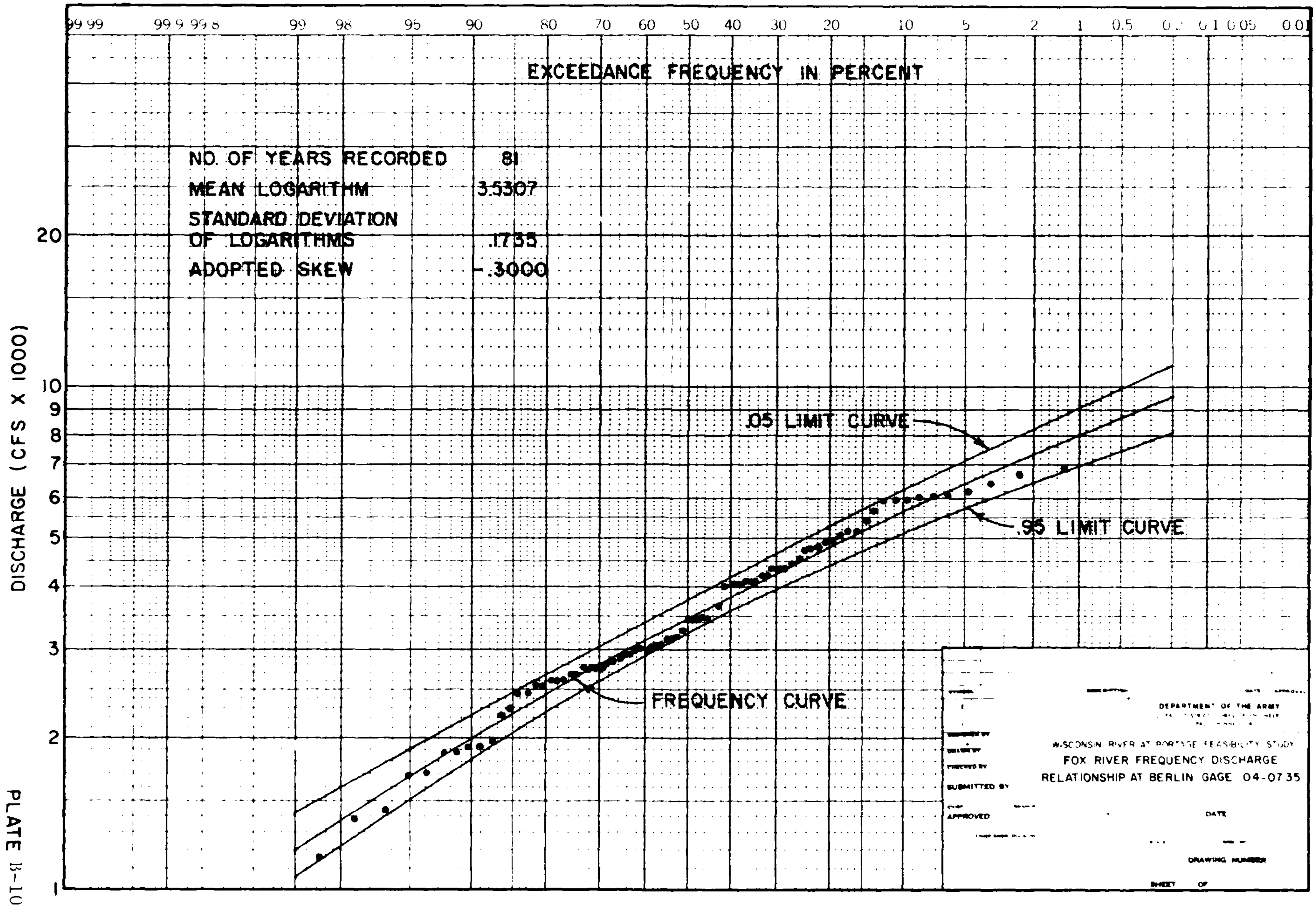
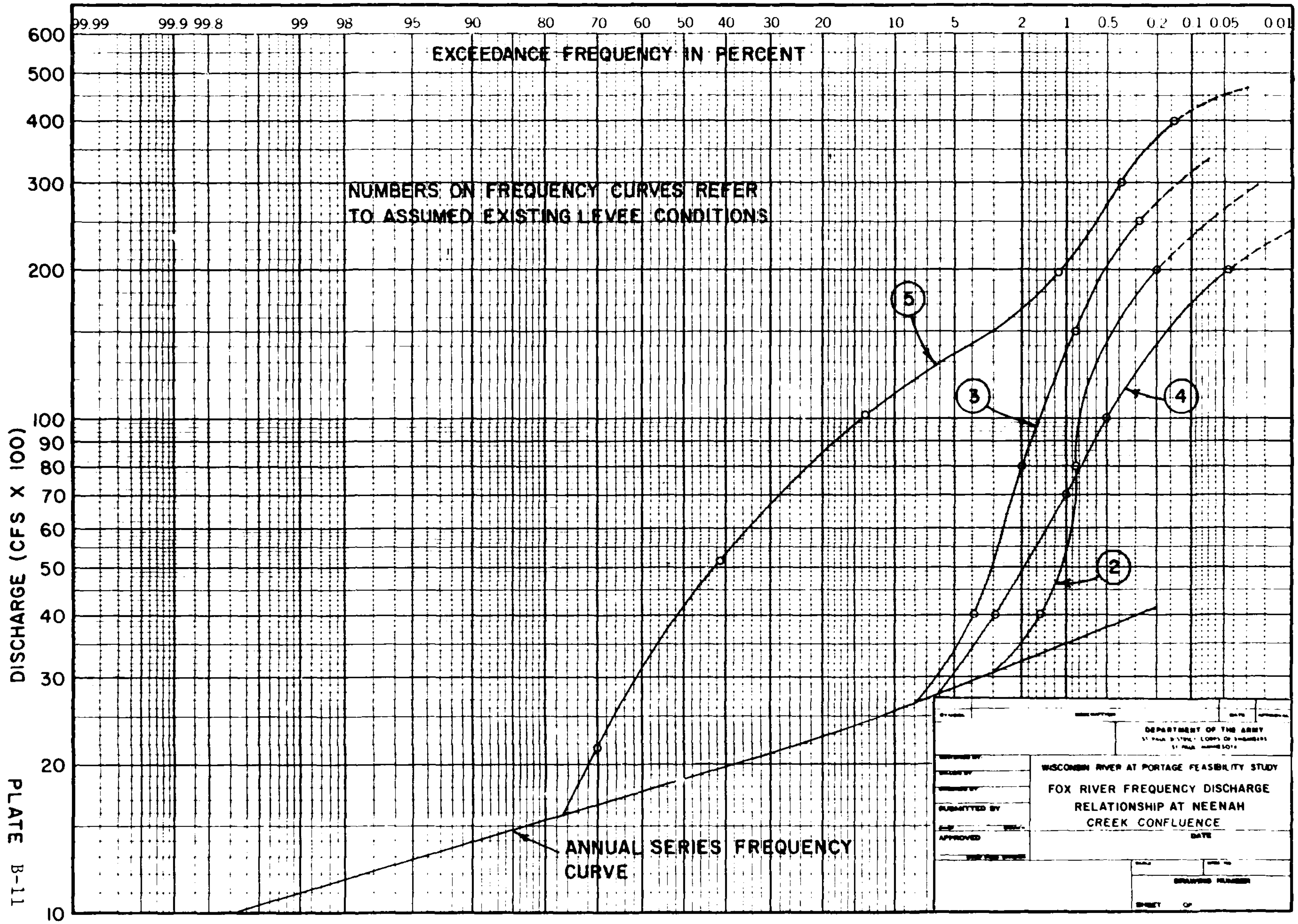

EXCEEDANCE FREQUENCY IN PERCENT
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
DISCHARGE (CFS)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
9000
8000
7000
6000
WISCONSIN RIVER AT X-SECTION AD
WISCONSIN RIVER DOWNSTREAM OF BARABOO CONFLUENCE
WISCONSIN RIVER DOWNSTREAM OF DUCK CREEK CONFLUENCE
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
WISCONSIN RIVER FREQUENCY DISCHARGE RELATIONSHIPS FOR LEVEE CONDITION 2
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET
OF

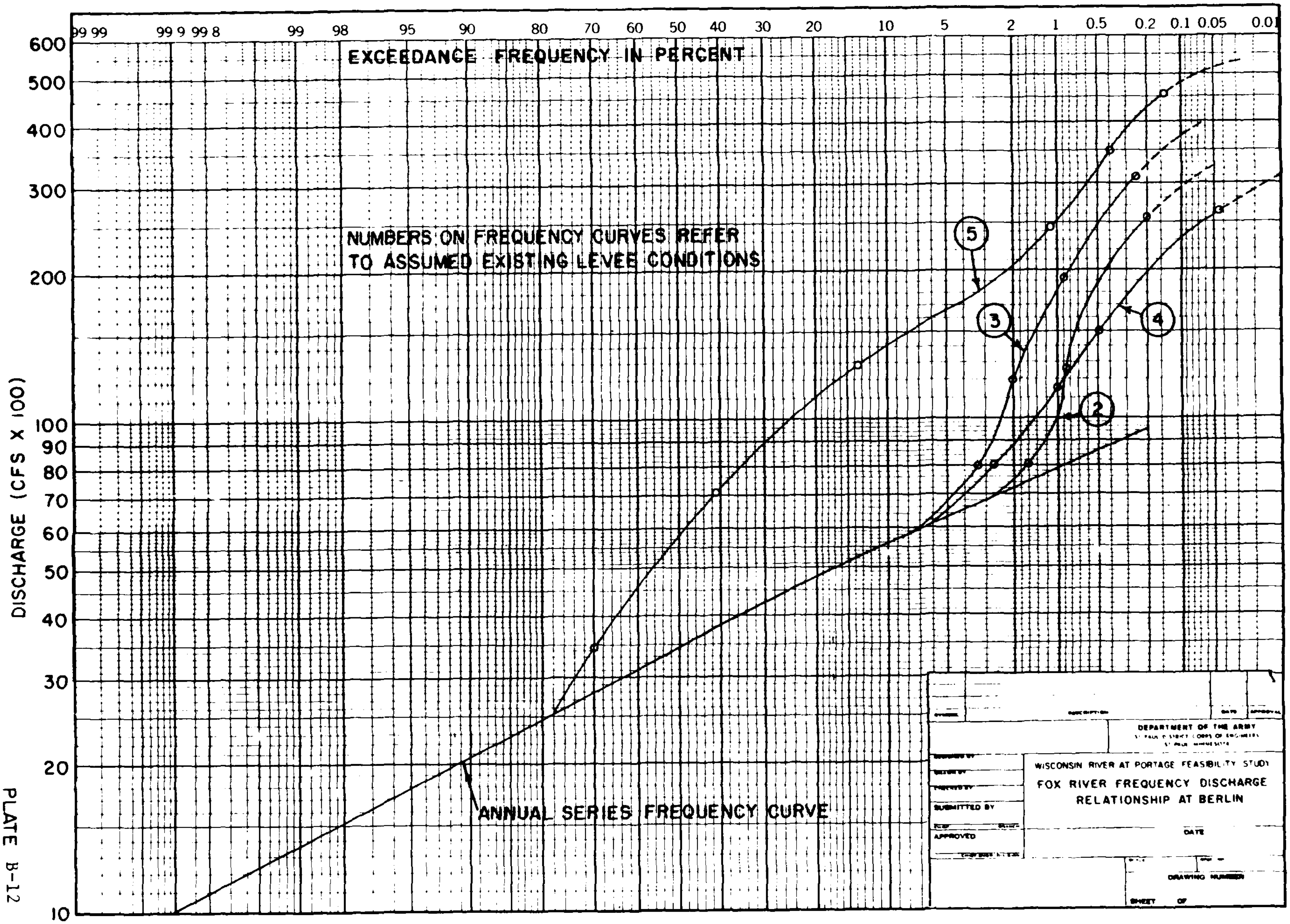
PLATE B-8


EXCEEDANCE FREQUENCY IN PERCENT
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
DISCHARGE (CFS X 1000) AT SECTION (AD)
100 90 80 70 60 50 40 30 20 10
LEVEE CONDITION 3
LEVEE CONDITION 4
LEVEE CONDITION 5
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
WISCONSIN RIVER FREQUENCY
DISCHARGE RELATIONSHIPS AT SECTION
(AD) FOR LEVEE CONDITIONS 3,4,& 5
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF



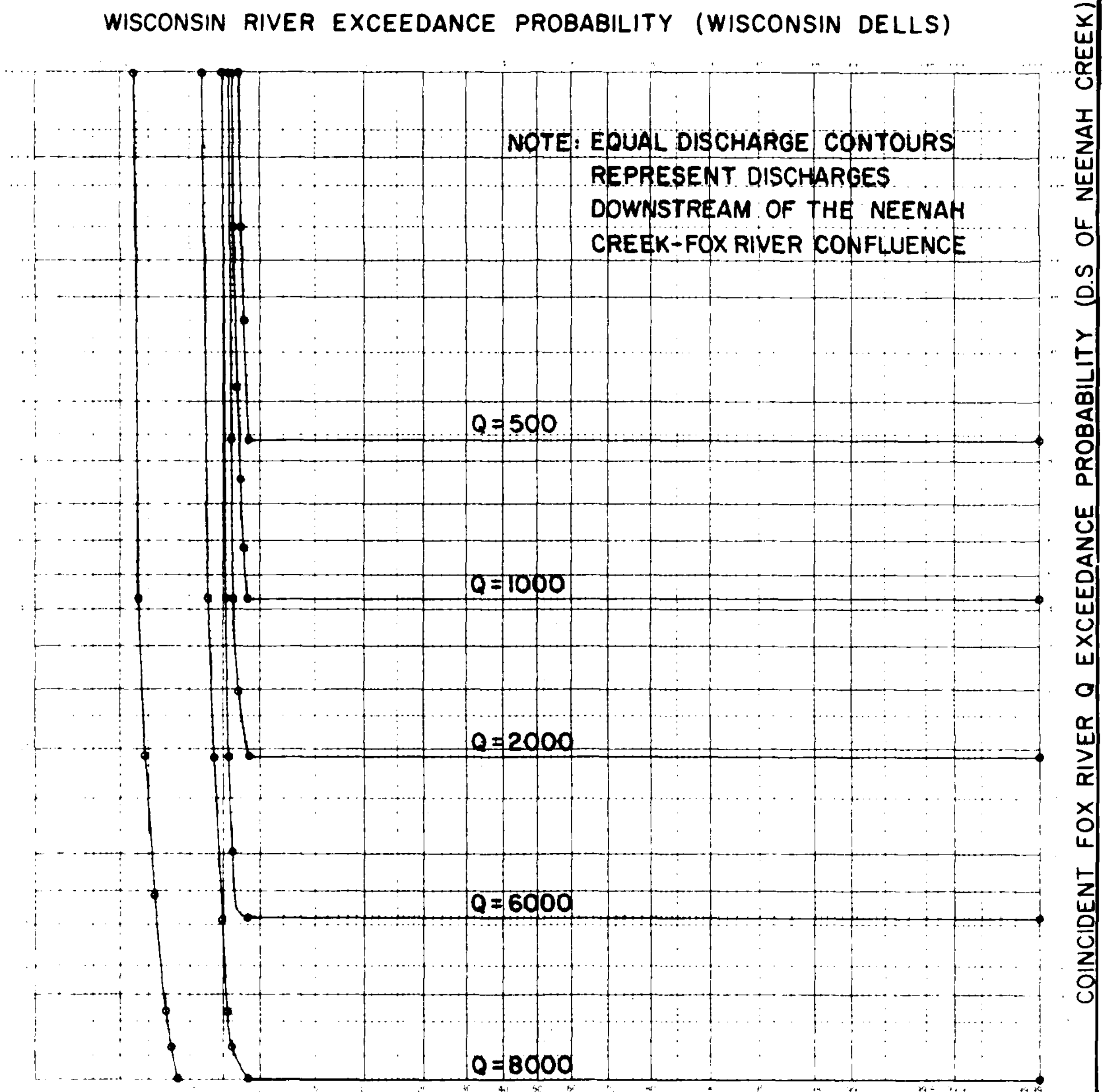
EXCEEDANCE FREQUENCY IN PERCENT
99.99
99.9 99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.01 0.05
0.01
DISCHARGE (CFS X 1000)
20
10
9
8
7
6
5
4
3
2
1
NO. OF YEARS RECORDED 81
MEAN LOGARITHM 3.5307
STANDARD DEVIATION OF LOGARITHMS .1735
ADOPTED SKEW -.3000
.05 LIMIT CURVE
.95 LIMIT CURVE
FREQUENCY CURVE
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FOX RIVER FREQUENCY DISCHARGE
RELATIONSHIP AT BERLIN GAGE 04-0735
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF


EXCEEDANCE FREQUENCY IN PERCENT
NUMBERS ON FREQUENCY CURVES REFER TO ASSUMED EXISTING LEVEE CONDITIONS
DISCHARGE (CFS X 100)
ANNUAL SERIES FREQUENCY CURVE
2
3
4
5
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FOX RIVER FREQUENCY DISCHARGE RELATIONSHIP AT NEENAH CREEK CONFLUENCE
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF



EXCEEDANCE FREQUENCY IN PERCENT
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
DISCHARGE (CFS X 100)
600 500 400 300 200 100 90 80 70 60 50 40 30 20 10
NUMBERS ON FREQUENCY CURVES REFER
TO ASSUMED EXISTING LEVEE CONDITIONS
2
3
4
5
ANNUAL SERIES FREQUENCY CURVE
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FOX RIVER FREQUENCY DISCHARGE
RELATIONSHIP AT BERLIN
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

PLATE B-12



DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

EQUAL FOX RIVER DISCHARGE CONTOURS FOR THE LEVEES OVERTOPPED BUT NOT BREACHED CONDITION

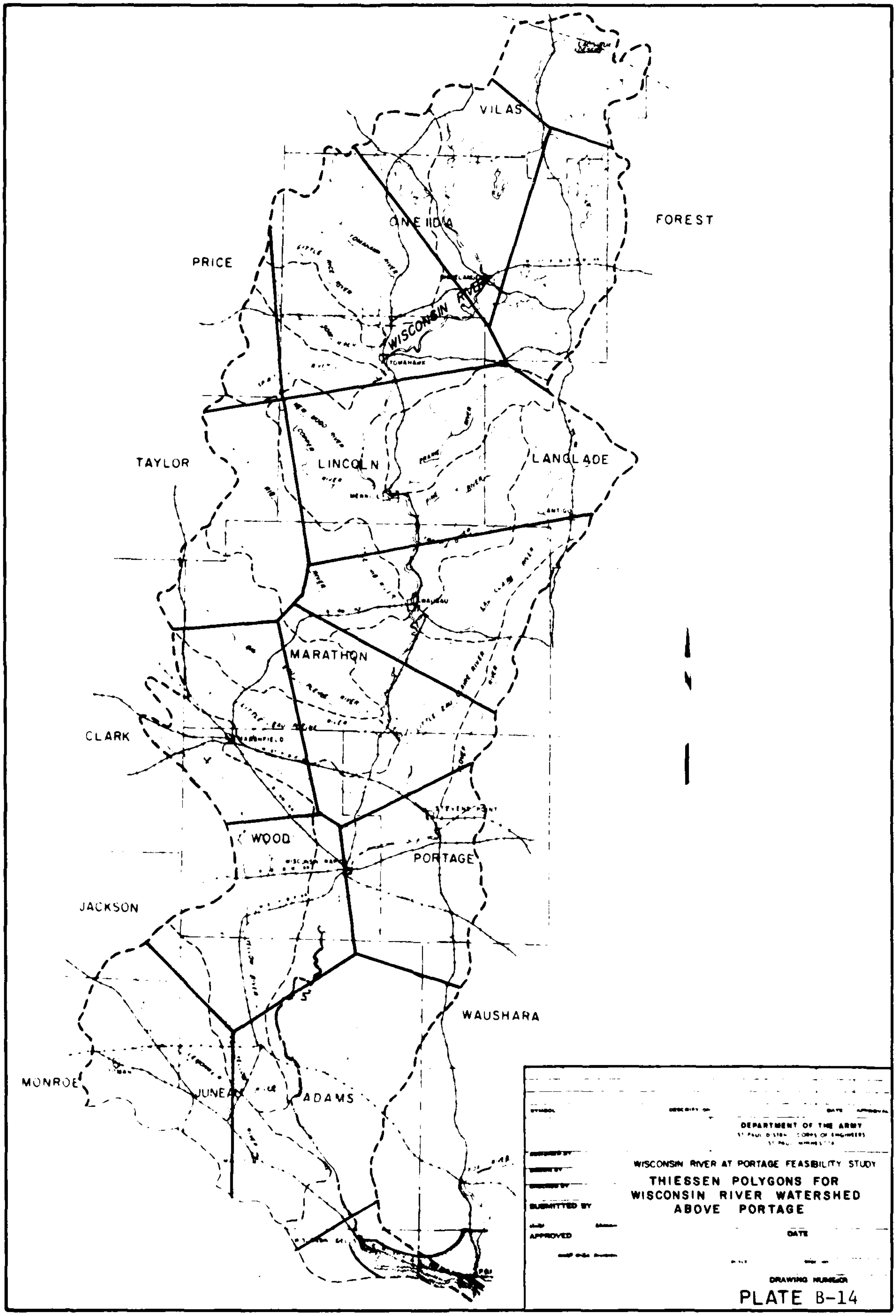
SUBMITTED BY

APPROVED

DATE

DRAWING NUMBER

PLATE B-13


VILAS
FOREST
ONEIDA
PRICE
WISCONSIN RIVER
TAYLOR
LINCOLN
LANGLADE
MARATHON
CLARK
WOOD
PORTAGE
JACKSON
WAUSHARA
MONROE
JUNEAU
ADAMS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
THIESSEN POLYGONS FOR
WISCONSIN RIVER WATERSHED
ABOVE PORTAGE
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
PLATE B-14

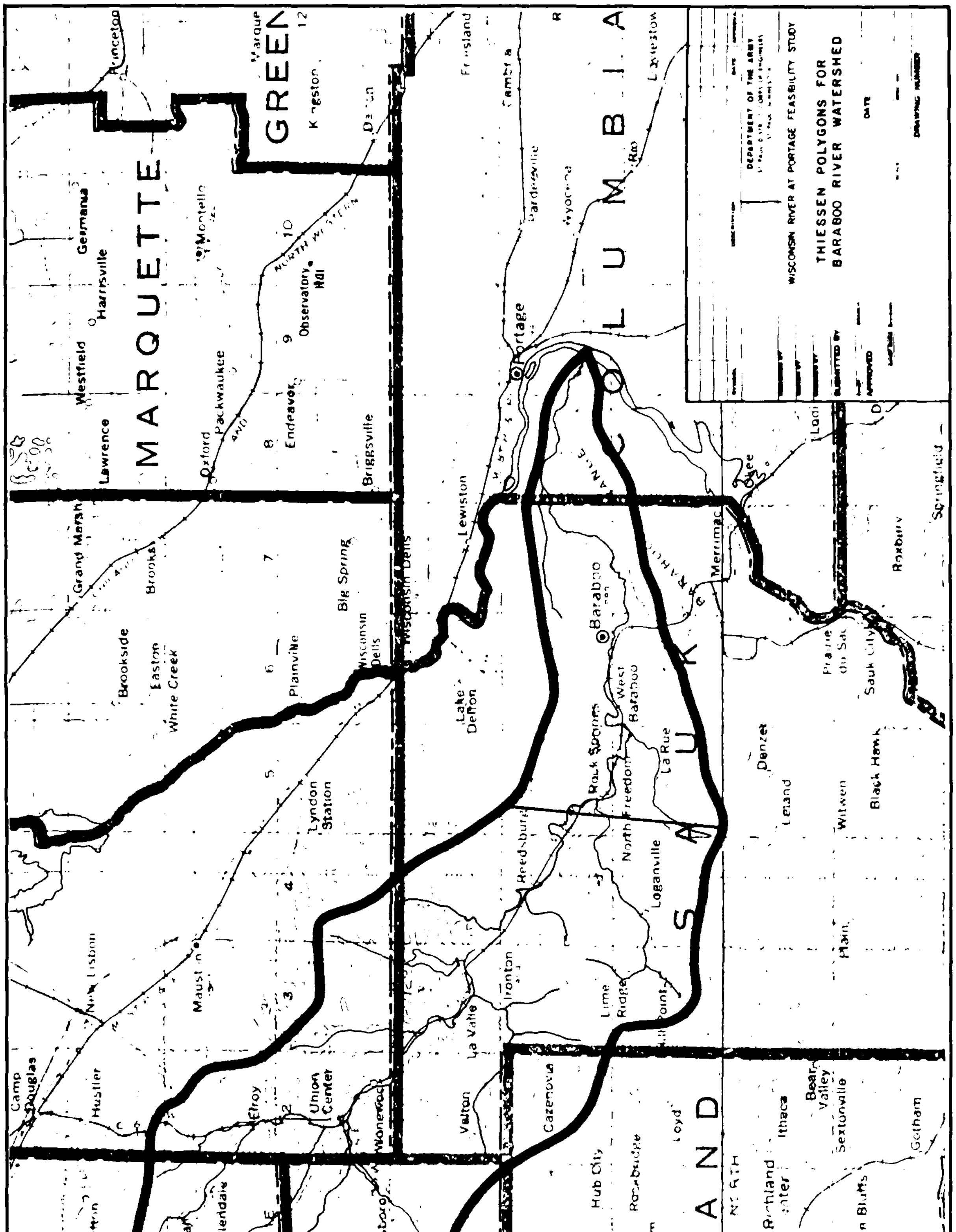

DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
THIESSEN POLYGONS FOR
BARABOO RIVER WATERSHED
MARQUETTE
GREEN
COLUMBIA
SAUK
RICHLAND
Portage
Baraboo
Wisconsin Dells
Reedsburg
Elroy
Mauston
Lake Delton
West Baraboo
Rock Springs
North Freedom
Loganville
Lime Ridge
Ironton
La Valle
Union Center
Wonewoc
Hillsboro
Kendall
Glendale
Cazenovia
Hub City
Westfield
Oxford
Endeavor
Briggsville
Lyndon Station
Plainville
Big Spring
Lewiston
Merrimac
Prairie du Sac
Sauk City

PLATE B-15

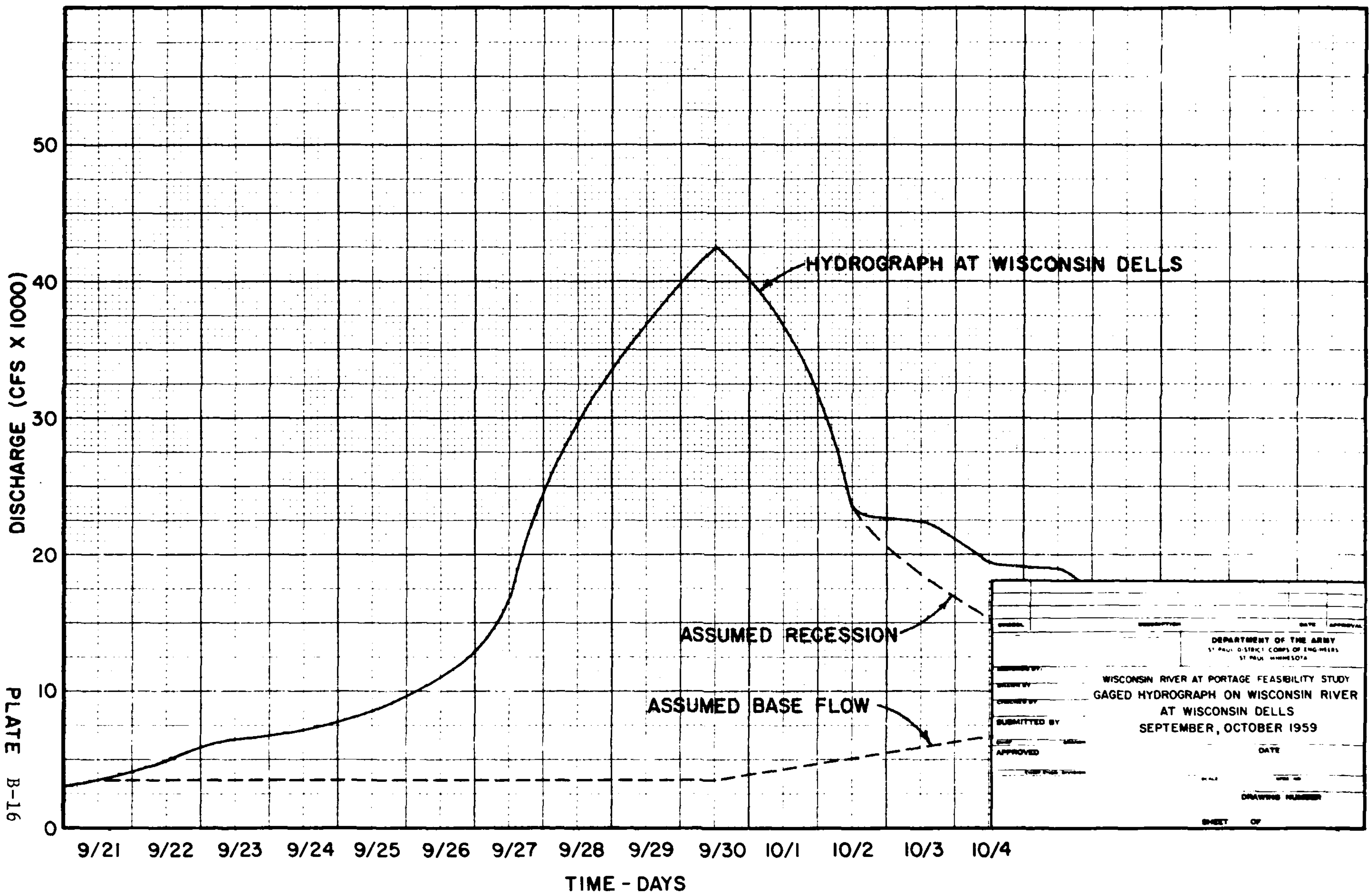

HYDROGRAPH AT WISCONSIN DELLS
ASSUMED RECESSION
ASSUMED BASE FLOW
DISCHARGE (CFS X 1000)
0
10
20
30
40
50
9/21
9/22
9/23
9/24
9/25
9/26
9/27
9/28
9/29
9/30
10/1
10/2
10/3
10/4
TIME - DAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
GAGED HYDROGRAPH ON WISCONSIN RIVER
AT WISCONSIN DELLS
SEPTEMBER, OCTOBER 1959
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

PLATE B-16

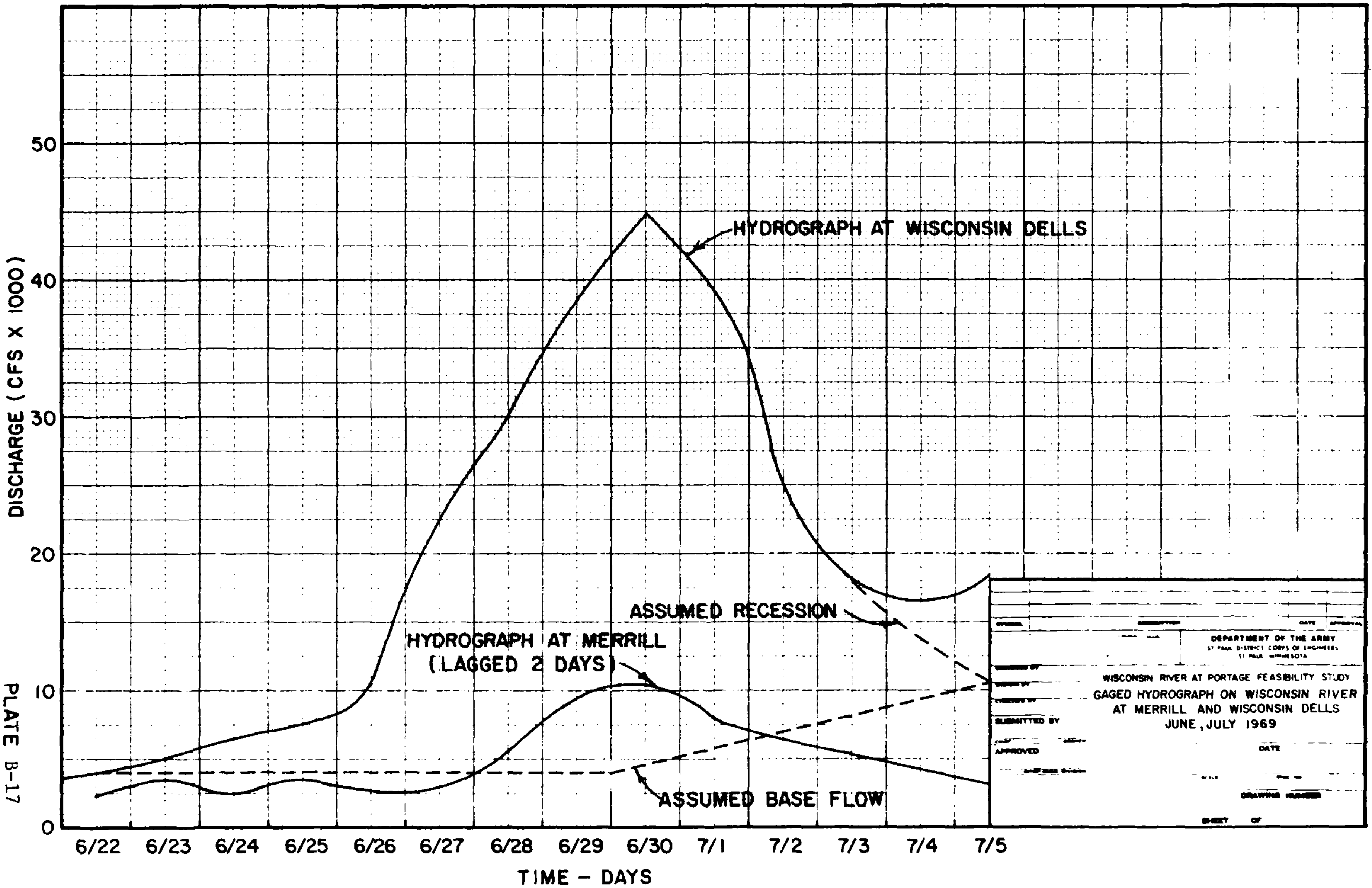
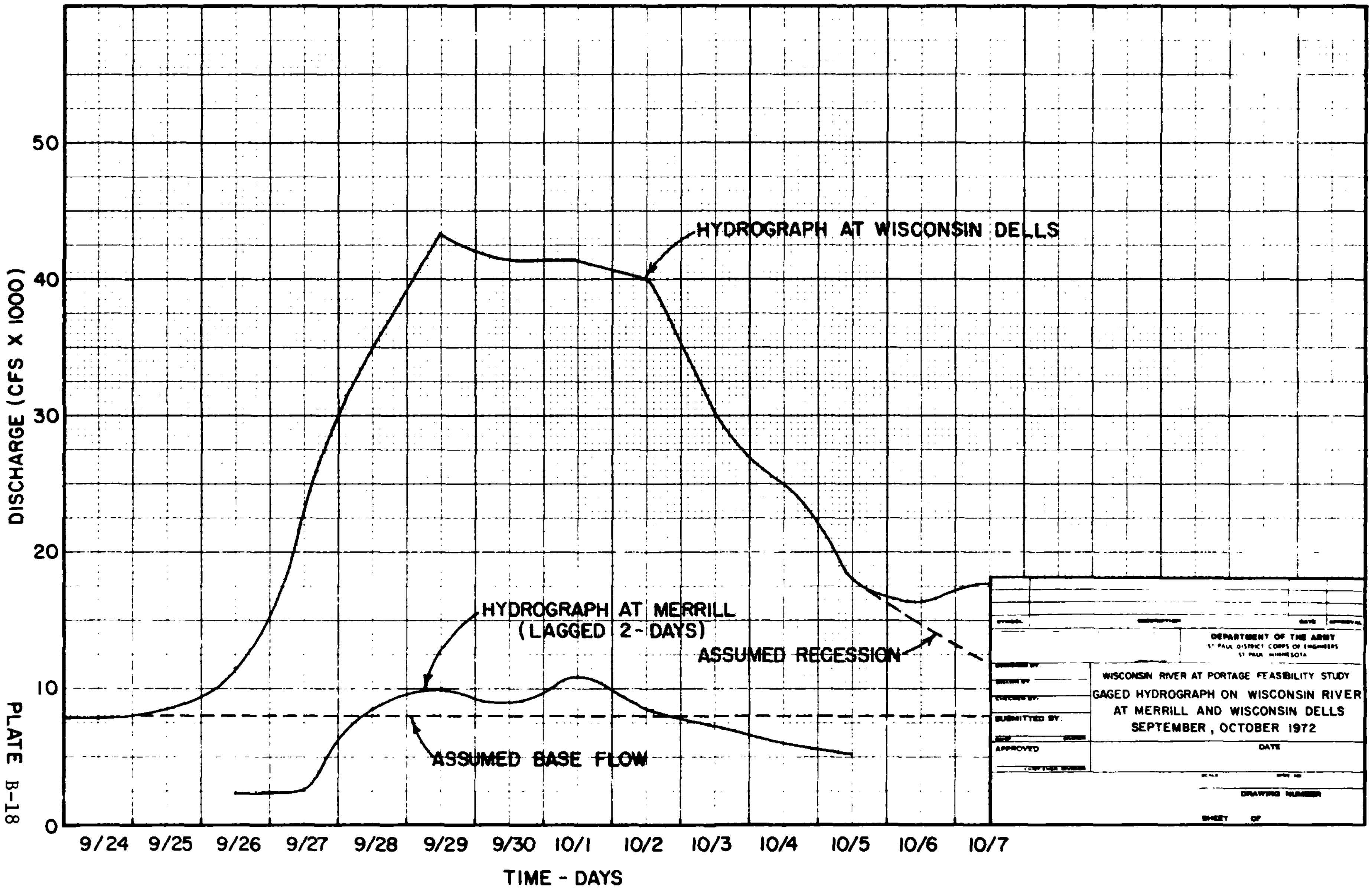
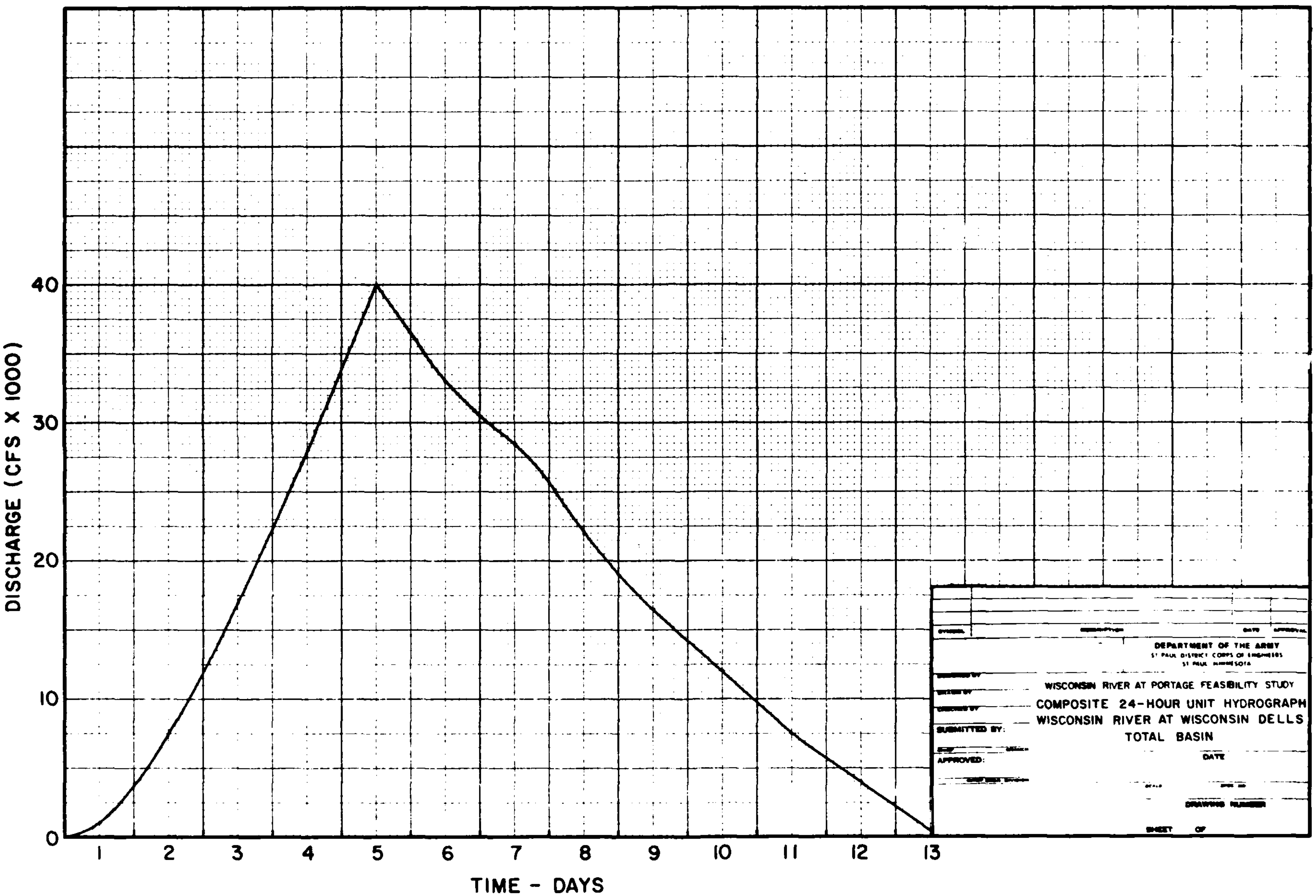

HYDROGRAPH AT WISCONSIN DELLS
ASSUMED RECESSION
HYDROGRAPH AT MERRILL (LAGGED 2 DAYS)
ASSUMED BASE FLOW
DISCHARGE (CFS X 1000)
0
10
20
30
40
50
6/22
6/23
6/24
6/25
6/26
6/27
6/28
6/29
6/30
7/1
7/2
7/3
7/4
7/5
TIME - DAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
GAGED HYDROGRAPH ON WISCONSIN RIVER
AT MERRILL AND WISCONSIN DELLS
JUNE, JULY 1969
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

PLATE B-17



HYDROGRAPH AT WISCONSIN DELLS
HYDROGRAPH AT MERRILL (LAGGED 2-DAYS)
ASSUMED REGESSION
ASSUMED BASE FLOW
DISCHARGE (CFS X 1000)
0
10
20
30
40
50
9/24
9/25
9/26
9/27
9/28
9/29
9/30
10/1
10/2
10/3
10/4
10/5
10/6
10/7
TIME - DAYS
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
GAGED HYDROGRAPH ON WISCONSIN RIVER
AT MERRILL AND WISCONSIN DELLS
SEPTEMBER, OCTOBER 1972
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

PLATE B-18



DISCHARGE (CFS X 1000)
0
10
20
30
40
1
2
3
4
5
6
7
8
9
10
11
12
13
TIME - DAYS
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
COMPOSITE 24-HOUR UNIT HYDROGRAPH
WISCONSIN RIVER AT WISCONSIN DELLS
TOTAL BASIN
SUBMITTED BY:
APPROVED:
DATE
DRAWING NUMBER
SHEET OF

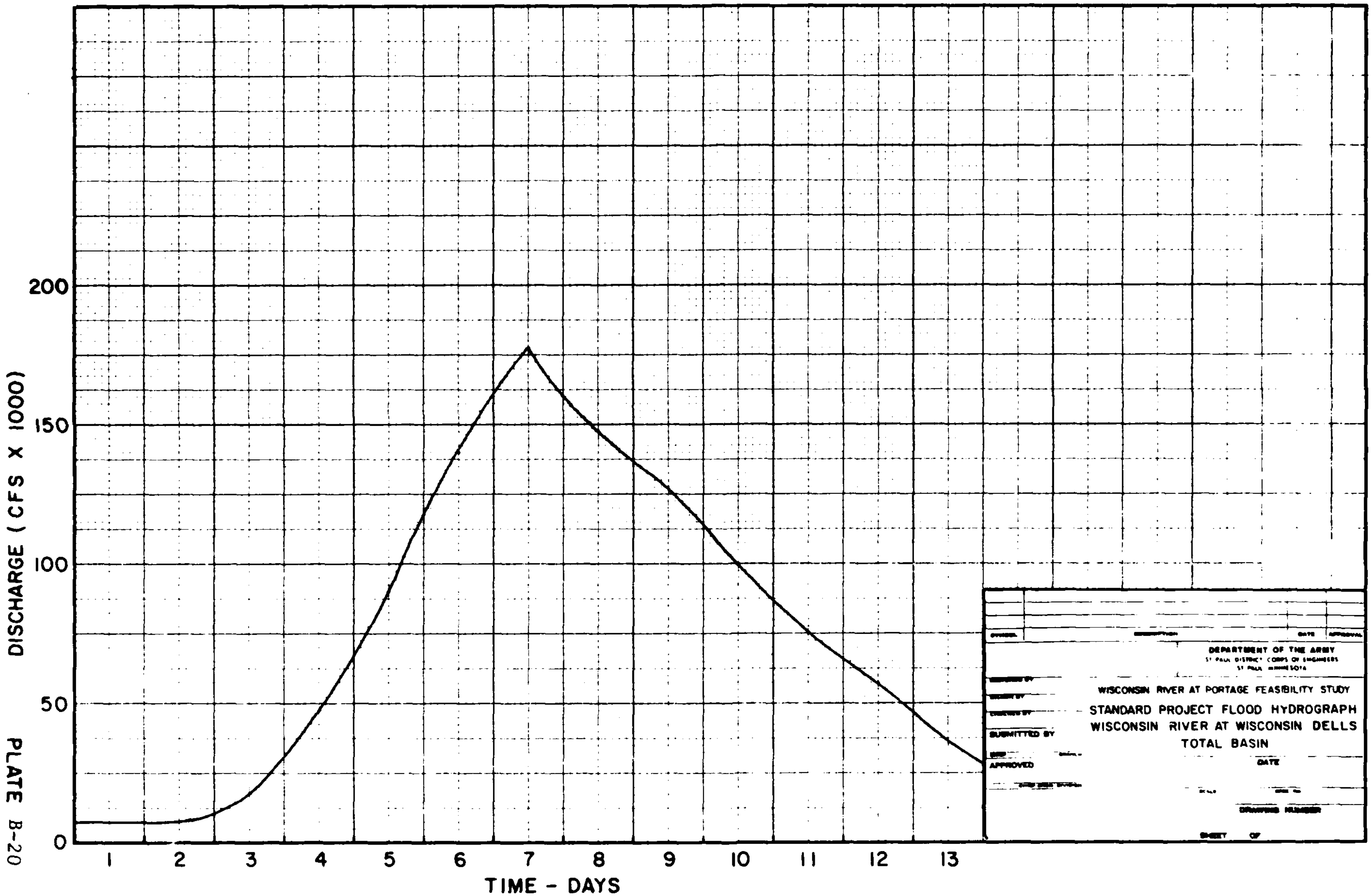
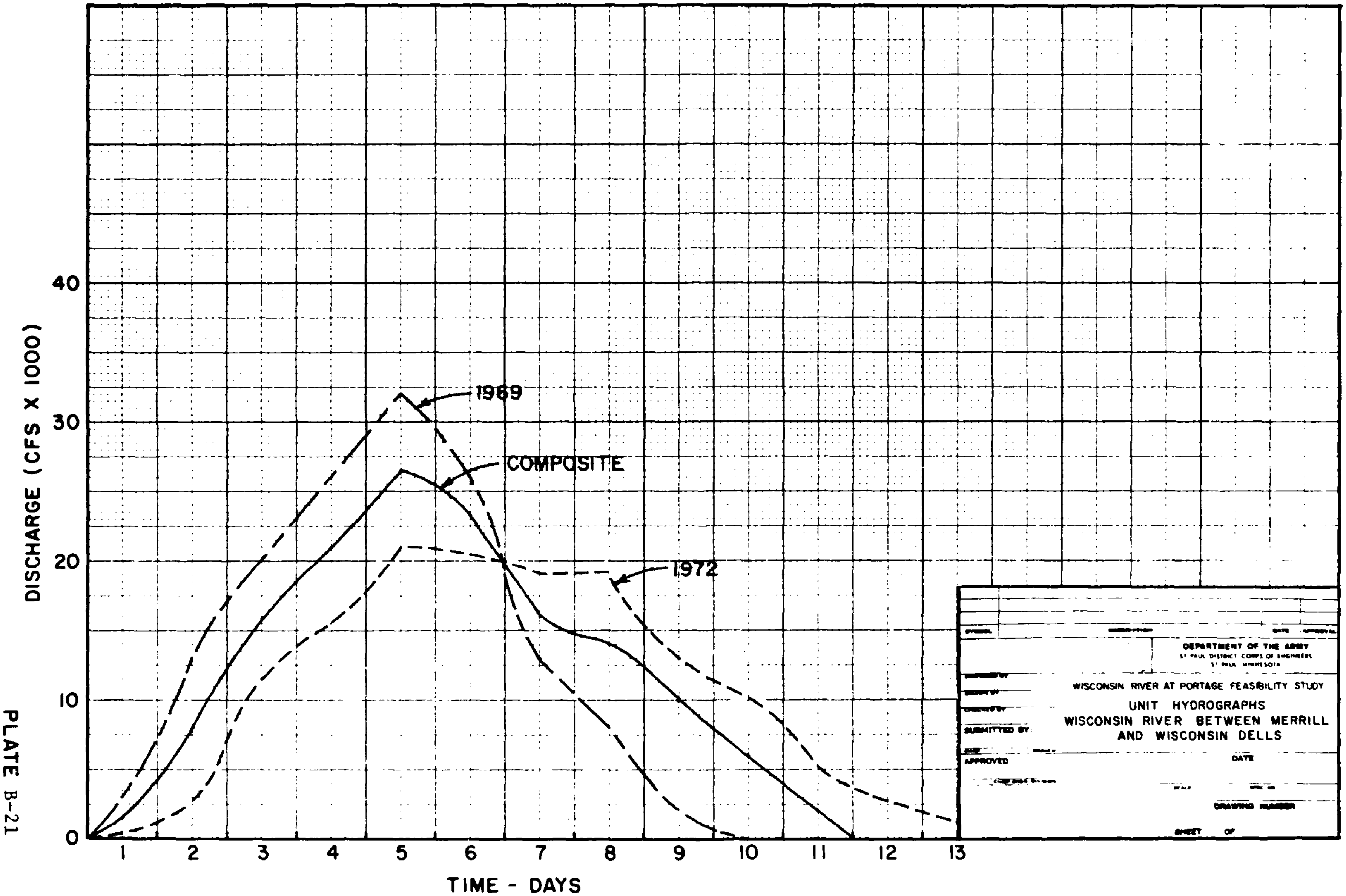

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
STANDARD PROJECT FLOOD HYDROGRAPH
WISCONSIN RIVER AT WISCONSIN DELLS
TOTAL BASIN
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF
DISCHARGE (CFS X 1000)
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12
13
TIME - DAYS

PLATE B-20


DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
UNIT HYDROGRAPHS
WISCONSIN RIVER BETWEEN MERRILL
AND WISCONSIN DELLS
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF
1969
COMPOSITE
1972
DISCHARGE (CFS X 1000)
TIME - DAYS
0
10
20
30
40
1
2
3
4
5
6
7
8
9
10
11
12
13

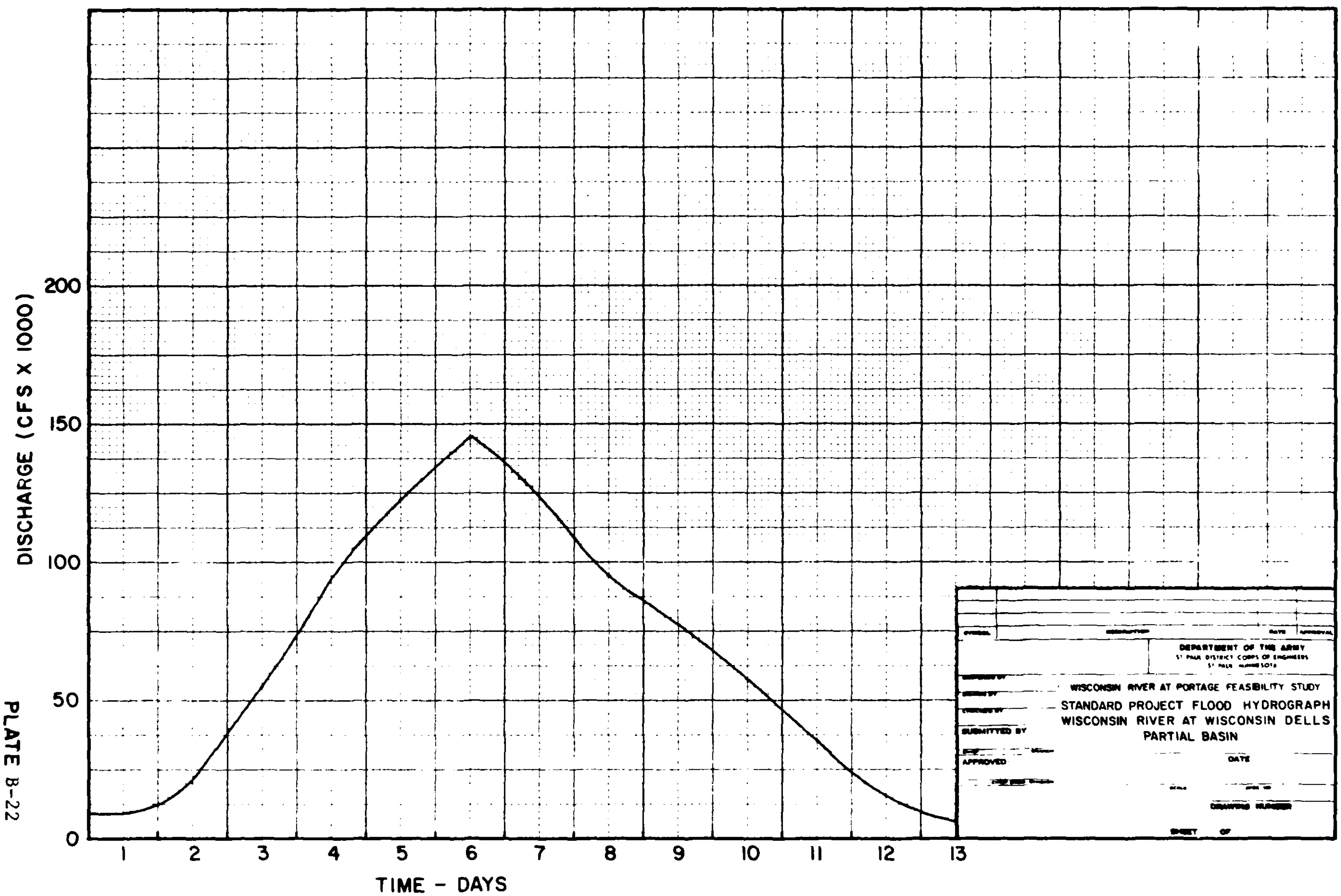

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
STANDARD PROJECT FLOOD HYDROGRAPH
WISCONSIN RIVER AT WISCONSIN DELLS
PARTIAL BASIN
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF
DISCHARGE (CFS X 1000)
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12
13
TIME - DAYS

PLATE B-22

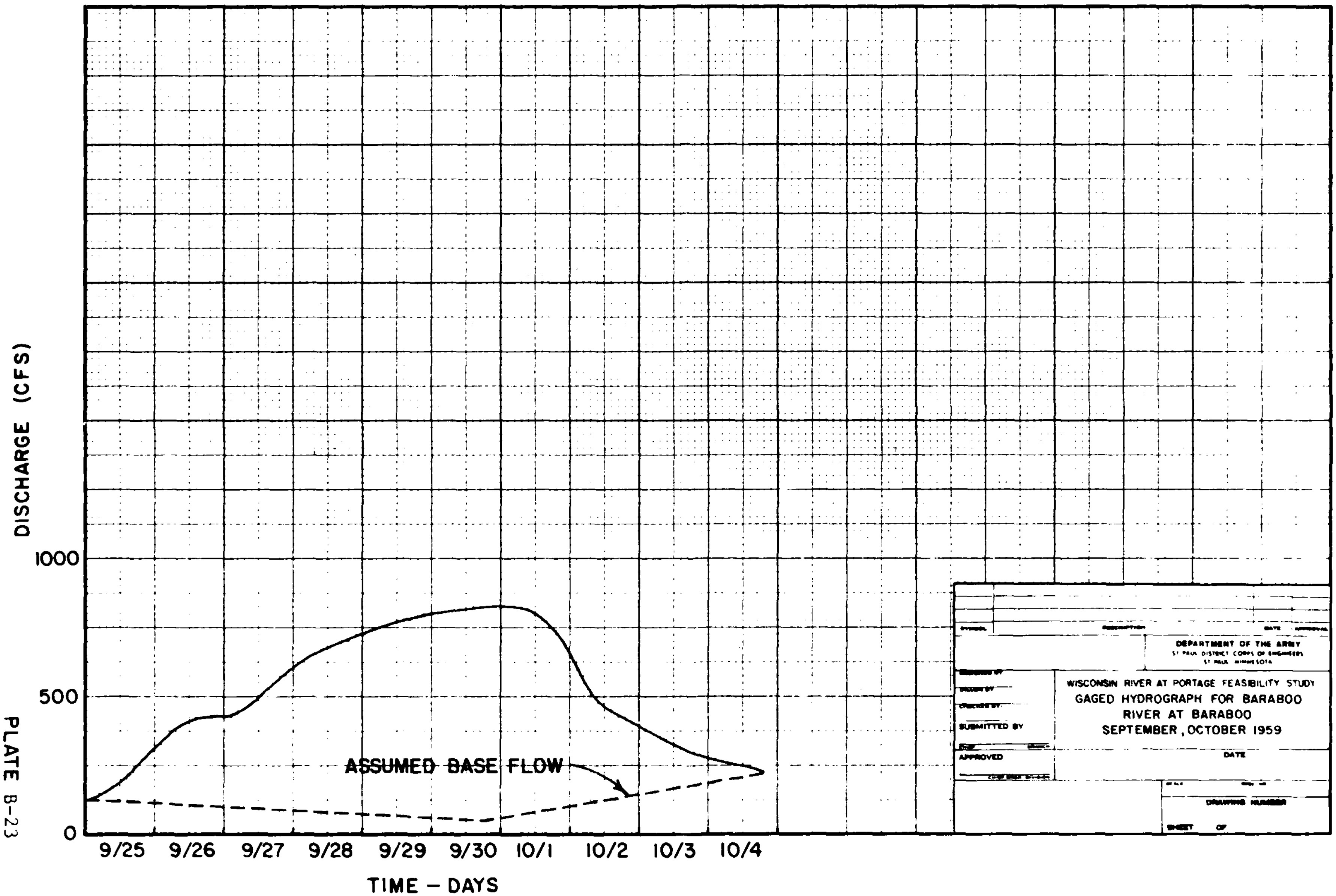

DISCHARGE (CFS)
1000
500
0
9/25
9/26
9/27
9/28
9/29
9/30
10/1
10/2
10/3
10/4
TIME — DAYS
ASSUMED BASE FLOW
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
GAGED HYDROGRAPH FOR BARABOO
RIVER AT BARABOO
SEPTEMBER, OCTOBER 1959
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

PLATE B-23

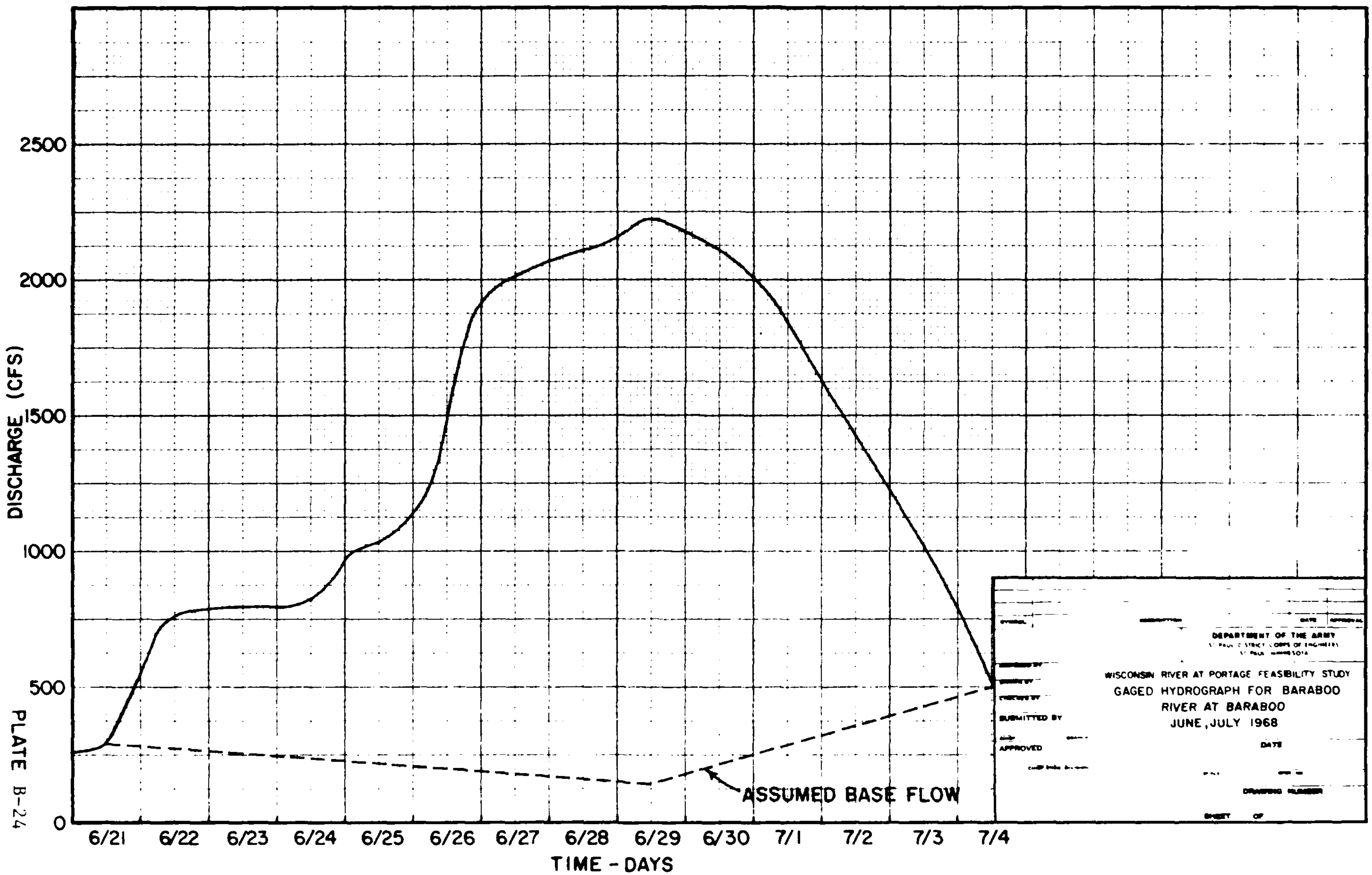
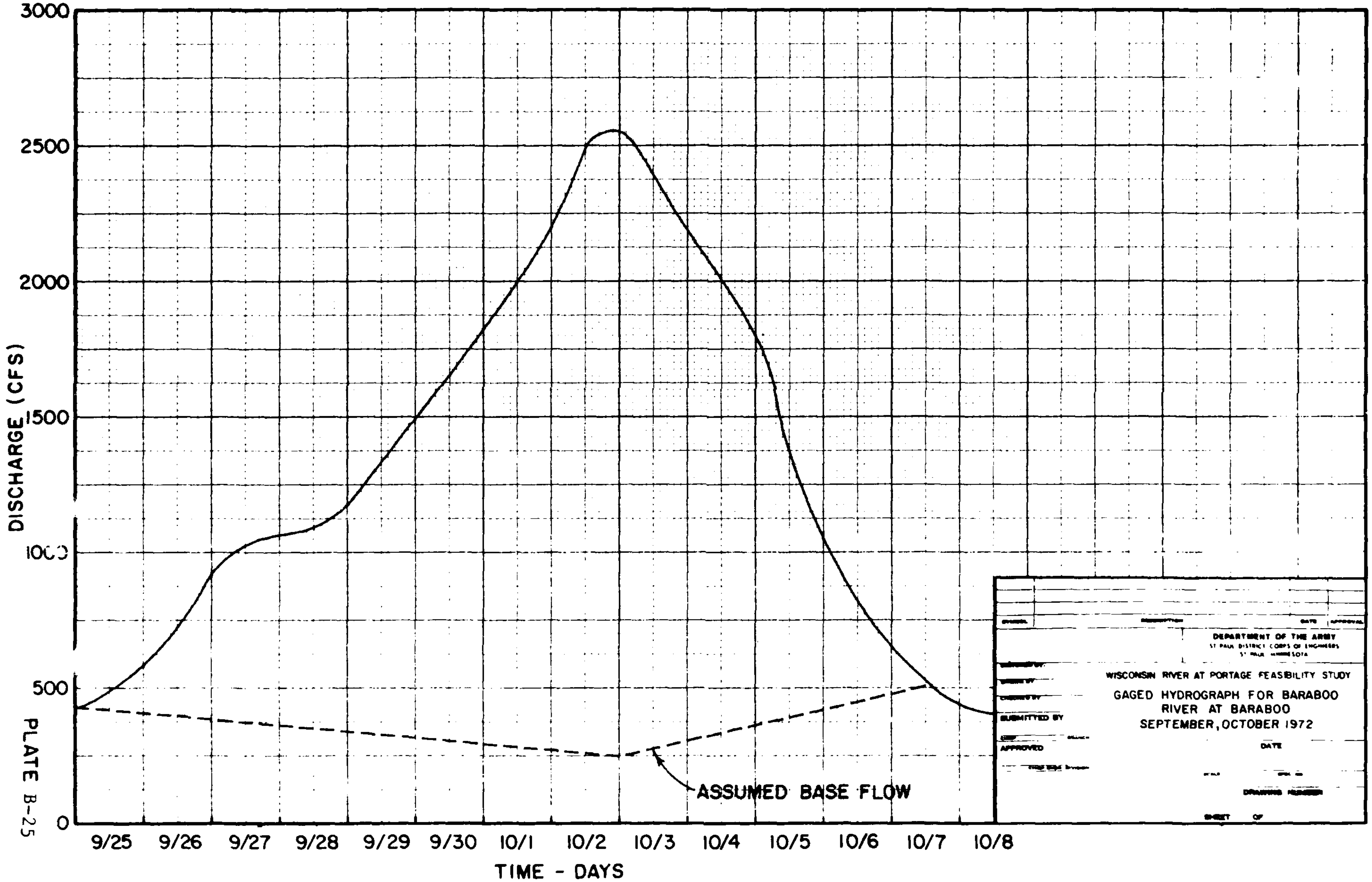
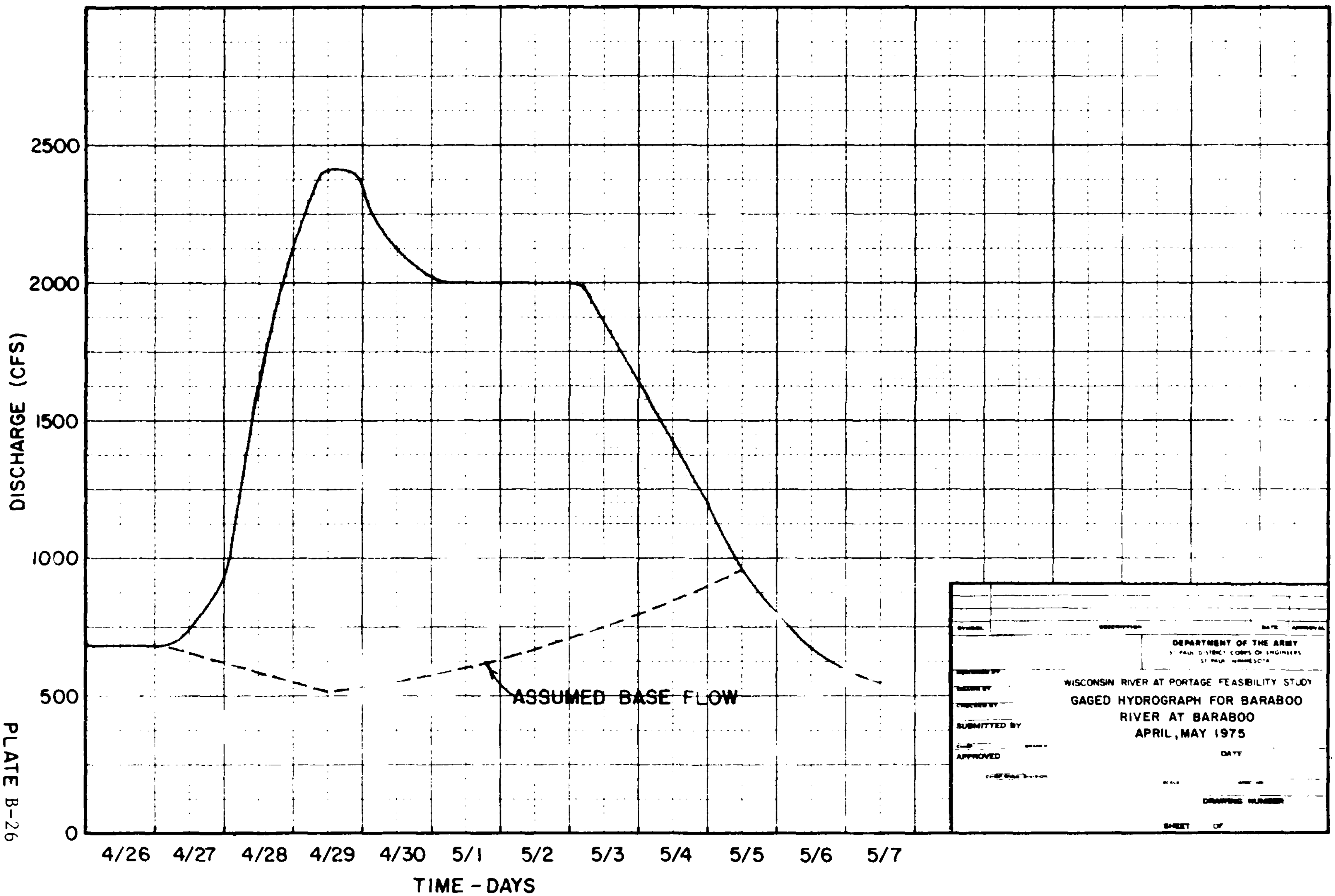

2500
2000
1500
1000
500
0
DISCHARGE (CFS)
6/21
6/22
6/23
6/24
6/25
6/26
6/27
6/28
6/29
6/30
7/1
7/2
7/3
7/4
TIME - DAYS
ASSUMED BASE FLOW
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
GAGED HYDROGRAPH FOR BARABOO
RIVER AT BARABOO
JUNE, JULY 1968
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

PLATE B-24

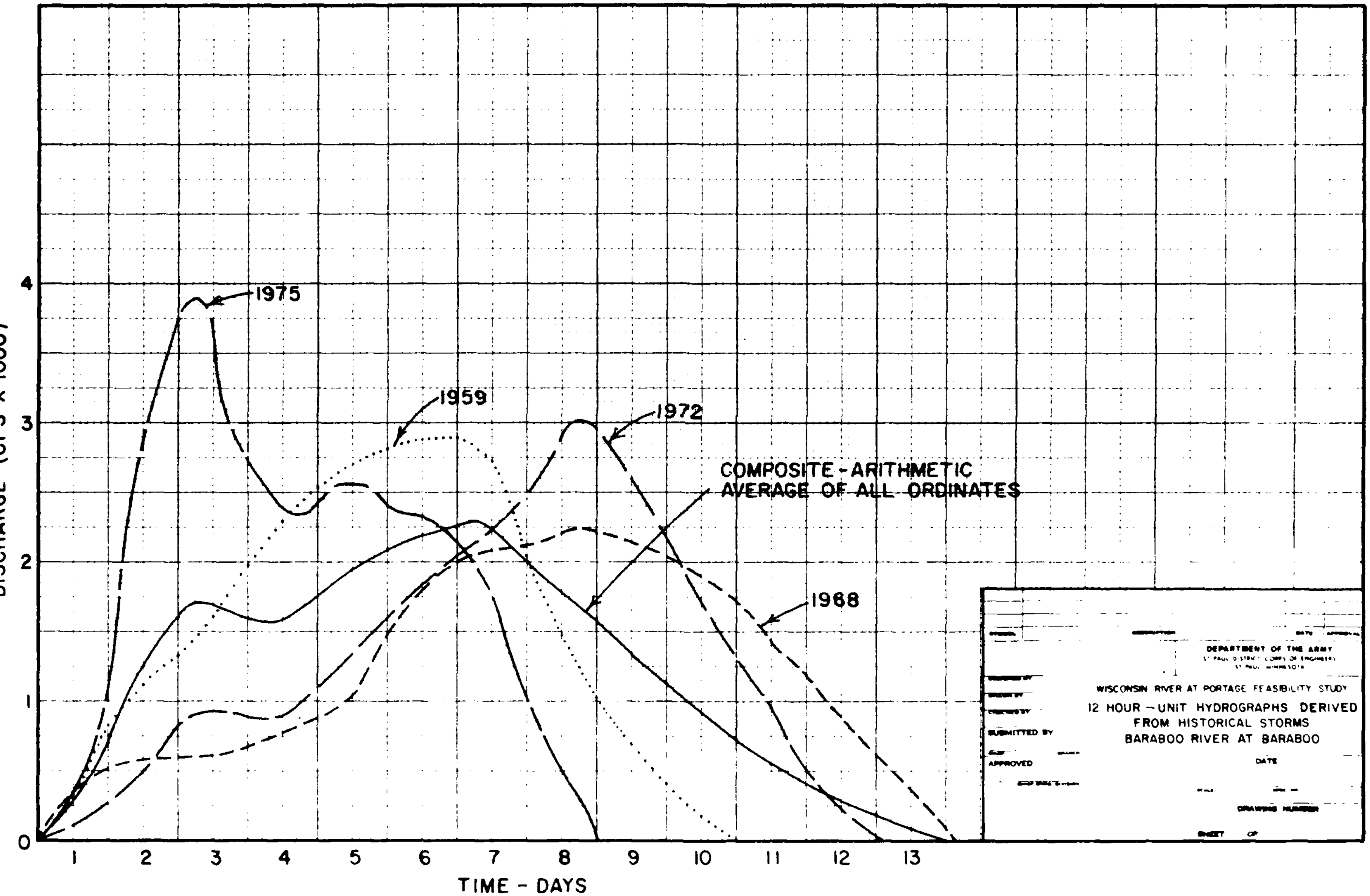


DISCHARGE (CFS)
3000
2500
2000
1500
1000
500
0
9/25
9/26
9/27
9/28
9/29
9/30
10/1
10/2
10/3
10/4
10/5
10/6
10/7
10/8
TIME - DAYS
ASSUMED BASE FLOW
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
GAGED HYDROGRAPH FOR BARABOO
RIVER AT BARABOO
SEPTEMBER, OCTOBER 1972
SUBMITTED BY
APPROVED
DATE

PLATE B-25



WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
GAGED HYDROGRAPH FOR BARABOO
RIVER AT BARABOO
APRIL, MAY 1975


DISCHARGE (CFS X 1000)
TIME - DAYS
1975
1959
1972
1968
COMPOSITE - ARITHMETIC
AVERAGE OF ALL ORDINATES
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
12 HOUR - UNIT HYDROGRAPHS DERIVED
FROM HISTORICAL STORMS
BARABOO RIVER AT BARABOO
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

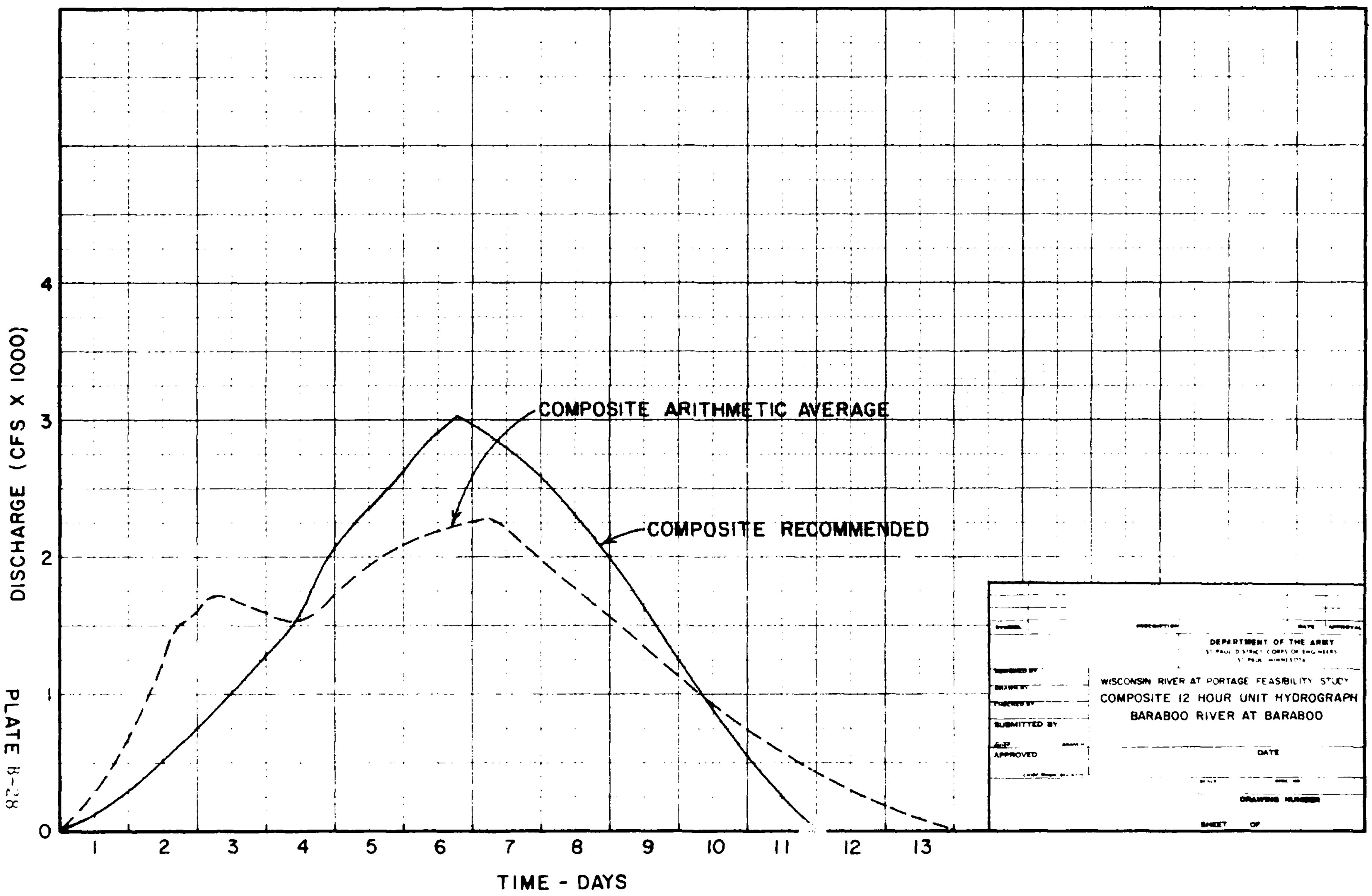

COMPOSITE ARITHMETIC AVERAGE
COMPOSITE RECOMMENDED
DISCHARGE (CFS X 1000)
0
1
2
3
4
TIME - DAYS
1
2
3
4
5
6
7
8
9
10
11
12
13
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
COMPOSITE 12 HOUR UNIT HYDROGRAPH
BARABOO RIVER AT BARABOO
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

PLATE B-28

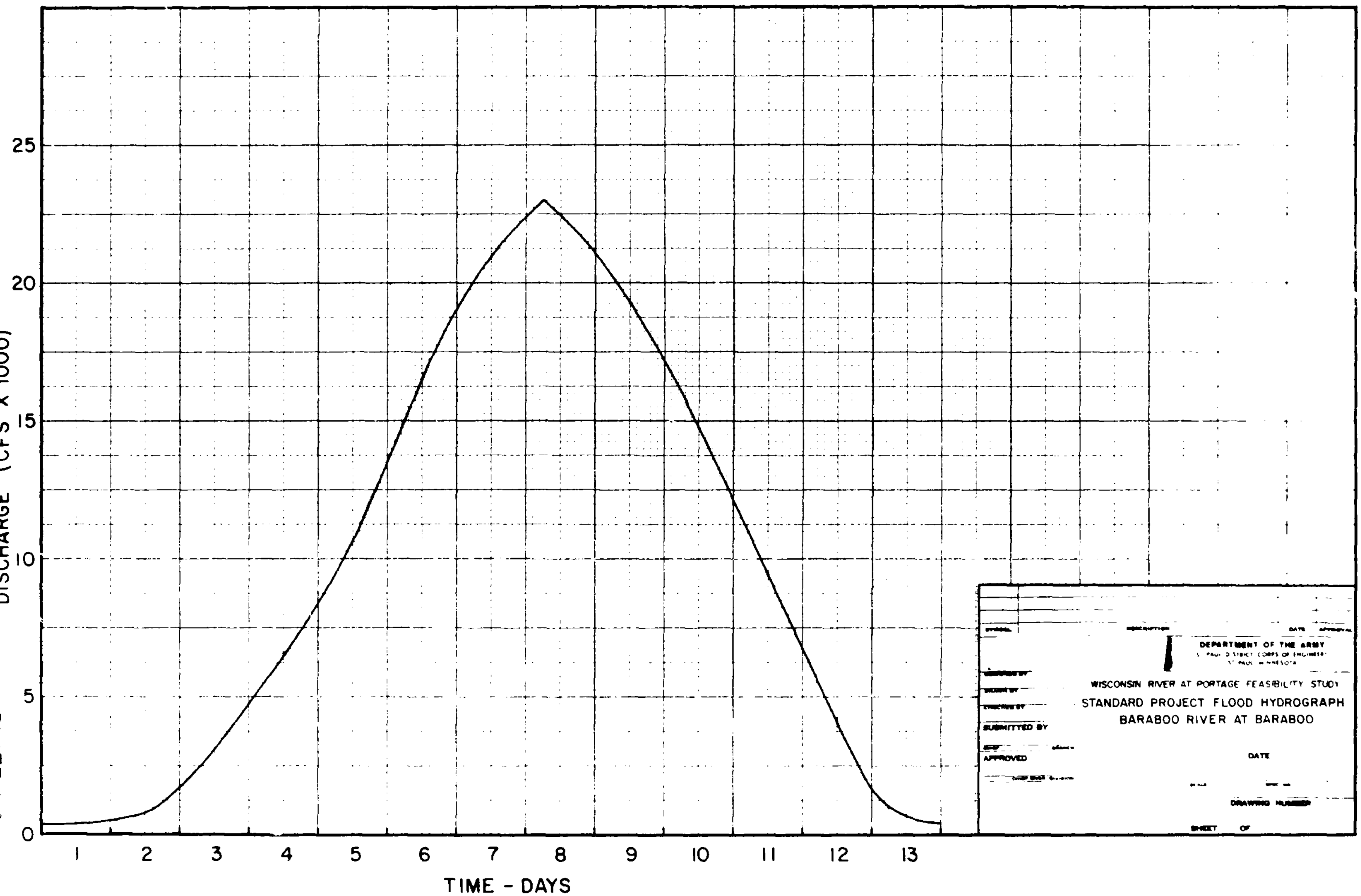
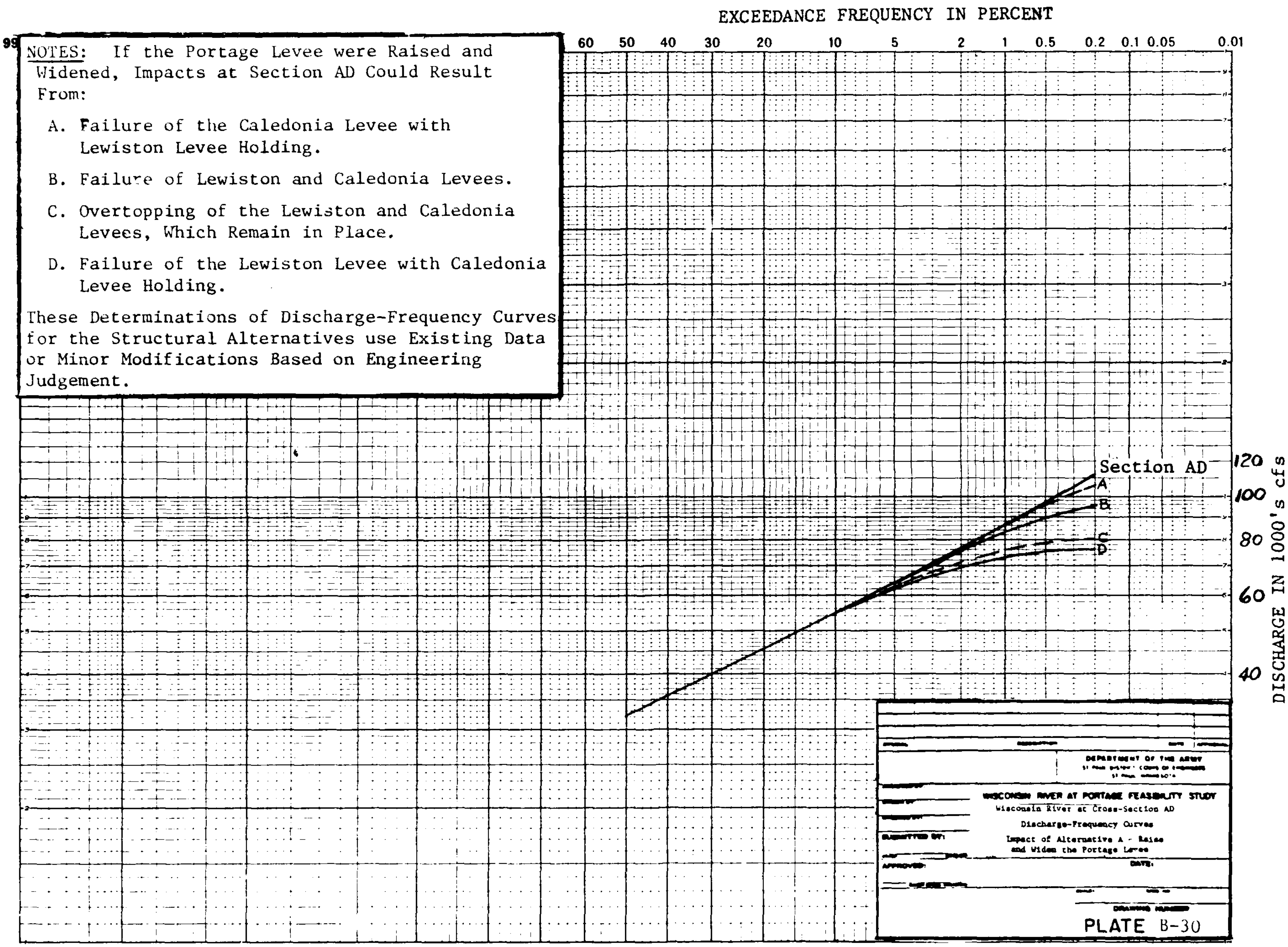

DISCHARGE (CFS X 1000)
0
5
10
15
20
25
1
2
3
4
5
6
7
8
9
10
11
12
13
TIME - DAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
STANDARD PROJECT FLOOD HYDROGRAPH
BARABOO RIVER AT BARABOO
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

PLATE 3-29



NOTES: If the Portage Levee were Raised and Widened, Impacts at Section AD Could Result From:

A. Failure of the Caledonia Levee with Lewiston Levee Holding.

B. Failure of Lewiston and Caledonia Levees.

C. Overtopping of the Lewiston and Caledonia Levees, Which Remain in Place.

D. Failure of the Lewiston Levee with Caledonia Levee Holding.

These Determinations of Discharge-Frequency Curves for the Structural Alternatives use Existing Data or Minor Modifications Based on Engineering Judgement.

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

Wisconsin River at Cross-Section AD

Discharge-Frequency Curves

Impact of Alternative A - Raise and Widen the Portage Levee

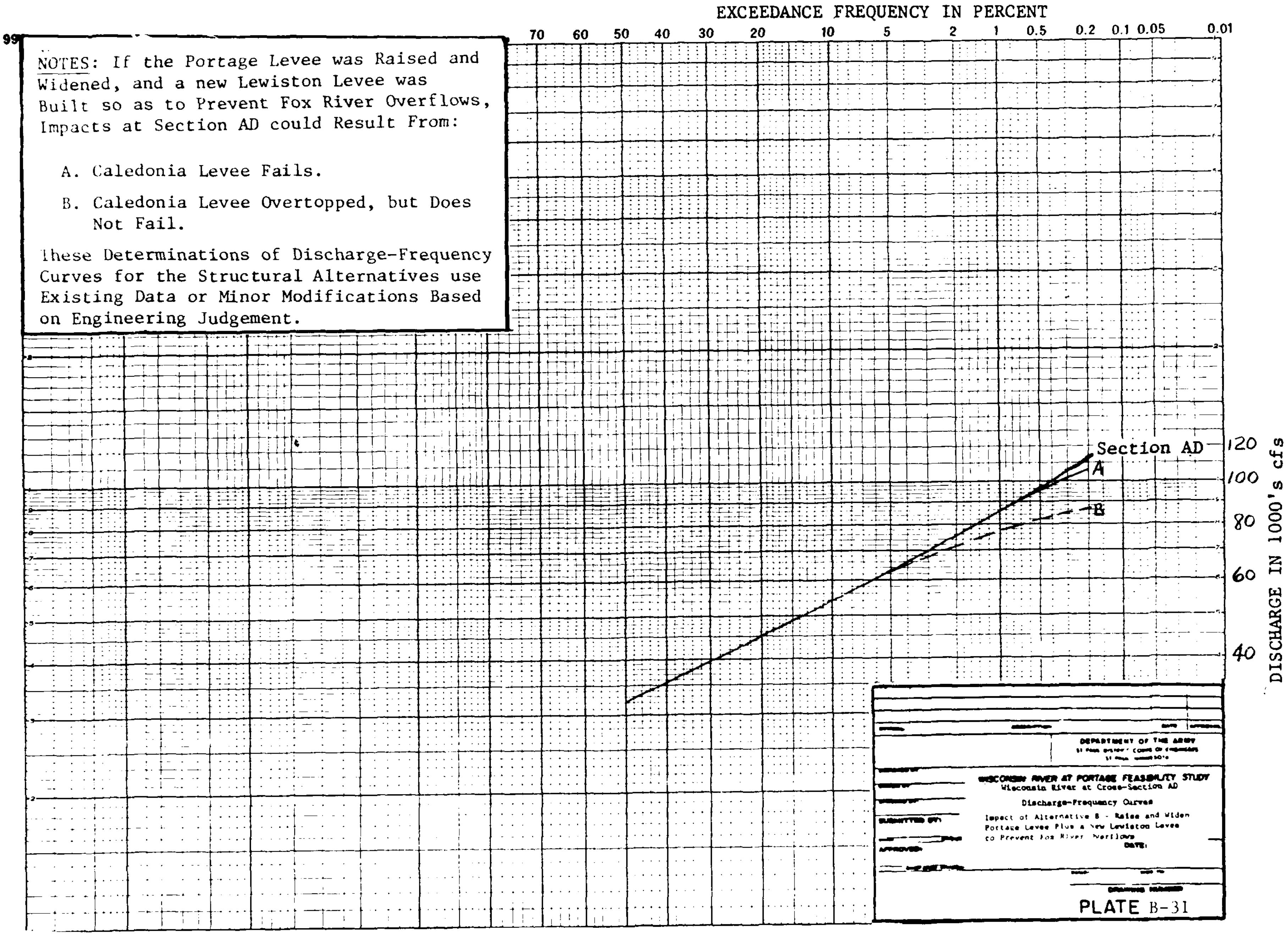
SUBMITTED BY:

APPROVED:

DATE:

DRAWING NUMBER

PLATE B-30



NOTES: If the Portage Levee was Raised and Widened, and a new Lewiston Levee was Built so as to Prevent Fox River Overflows, Impacts at Section AD could Result From:

A. Caledonia Levee Fails.

B. Caledonia Levee Overtopped, but Does Not Fail.

These Determinations of Discharge-Frequency Curves for the Structural Alternatives use Existing Data or Minor Modifications Based on Engineering Judgement.

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

Wisconsin River at Cross-Section AD

Discharge-Frequency Curves

Impact of Alternative B - Raise and Widen Portage Levee Plus a New Lewiston Levee to Prevent Fox River Overflows

PLATE B-31

NOTES: If the Portage Levee were Raised and Widened, Impacts Downstream of the mouth of the Baraboo River Could Result From:

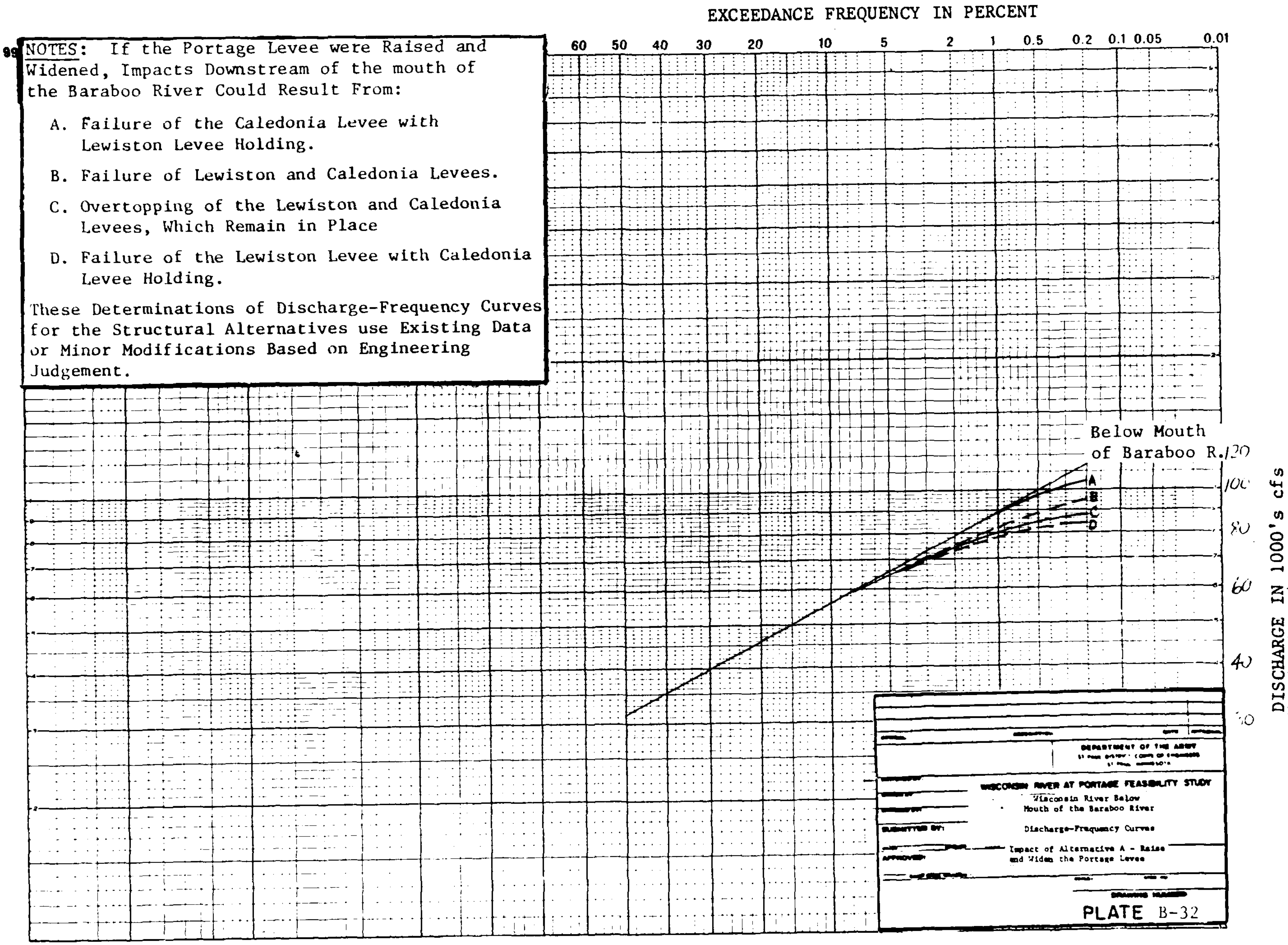
A. Failure of the Caledonia Levee with Lewiston Levee Holding.

B. Failure of Lewiston and Caledonia Levees.

C. Overtopping of the Lewiston and Caledonia Levees, Which Remain in Place

D. Failure of the Lewiston Levee with Caledonia Levee Holding.

These Determinations of Discharge-Frequency Curves for the Structural Alternatives use Existing Data or Minor Modifications Based on Engineering Judgement.

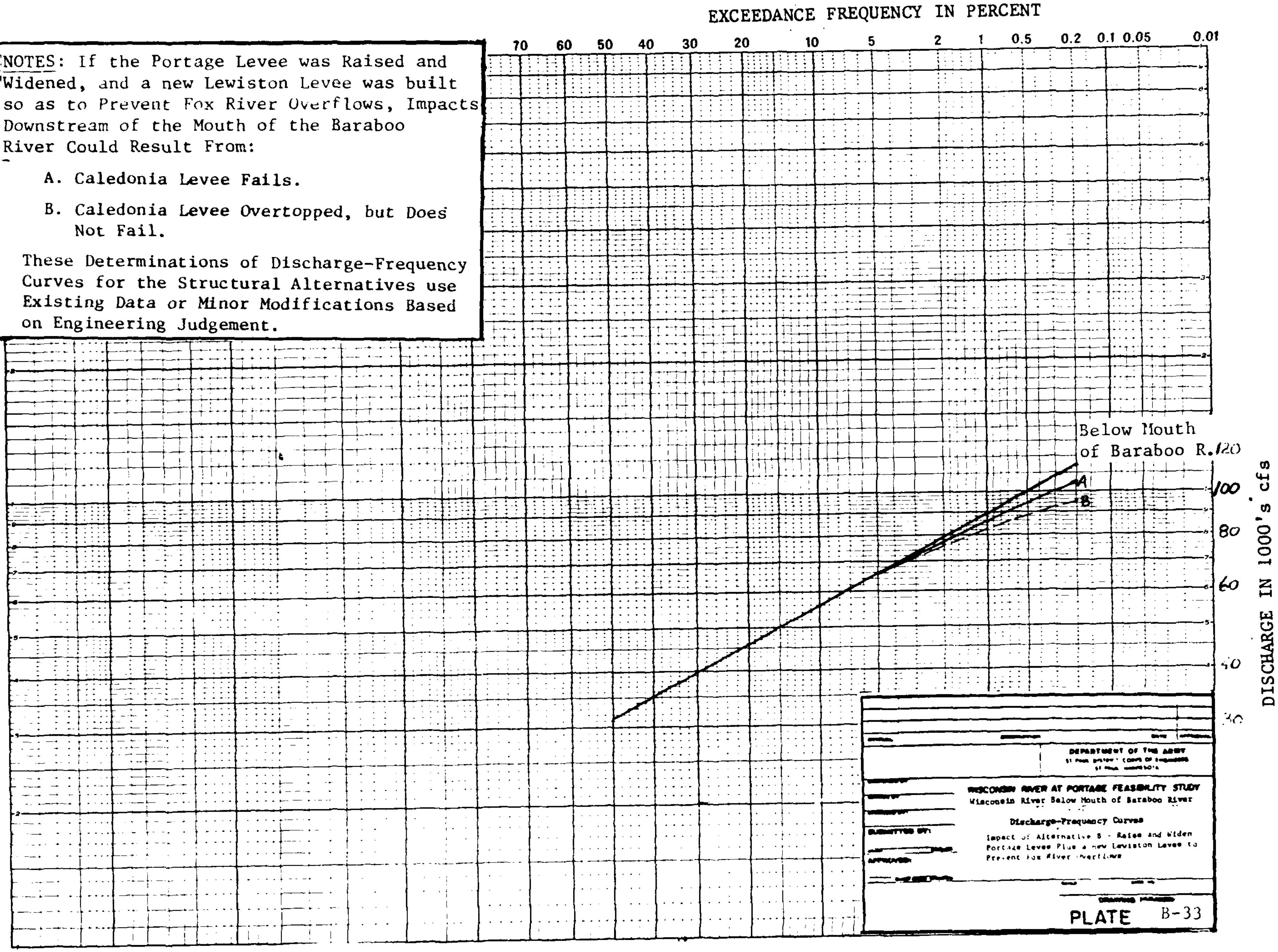


NOTES: If the Portage Levee was Raised and Widened, and a new Lewiston Levee was built so as to Prevent Fox River Overflows, Impacts Downstream of the Mouth of the Baraboo River Could Result From:

A. Caledonia Levee Fails.

B. Caledonia Levee Overtopped, but Does Not Fail.

These Determinations of Discharge-Frequency Curves for the Structural Alternatives use Existing Data or Minor Modifications Based on Engineering Judgement.



DEPARTMENT OF THE ARMY
St. Paul District, Corps of Engineers
St. Paul, Minnesota

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
Wisconsin River Below Mouth of Baraboo River

Discharge-Frequency Curves

Impact of Alternative B - Raise and Widen Portage Levee Plus a new Lewiston Levee to Prevent Fox River Overflows

PLATE B-33

FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER
at
PORTAGE, WISCONSIN

APPENDIX C

HYDRAULICS

December 1983

HYDRAULIC APPENDIX C

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONT.)

TABLE OF CONTENTS
(CONT.)

TABLES

TABLES
(CONT.)

TABLES
(CONT.)

FIGURES

PLATES

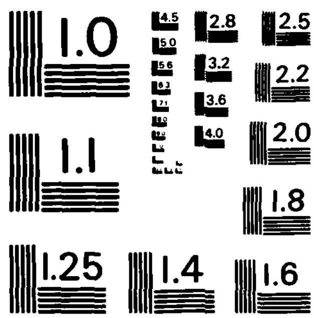
PLATES
(CONT.)

PLATES
(CONT.)

PLATES
(CONT.)

AD-A148 351 FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT WISCONSIN RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 83 3/9

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PLATES
(Cont)

HYDRAULIC APPENDIX

GENERAL

The study area lies in the Wisconsin River floodplain and extends from the Columbia-Sauk County line (river mile 122) near Lewiston downstream through Portage to the Interstate 90-94 bridge (river mile 106). Because of backwater and overflow effects of the Wisconsin River, however, portions of the tributaries of Duck Creek and the Baraboo River and part of the Upper Fox River basin were also included in the study. Portage is the major community within the study area. Levees exist within the Lewiston, Caledonia and Portage areas but are not built to Corps of Engineers' standards. There are many ways for the existing levees to fail, and for each of the possible modes of levee failure, the following was determined:

1. The effects of interbasin flow from the Wisconsin River to the Fox River.
2. Delineation of the Wisconsin River and the Baraboo River floodplain.

REFERENCES

1. U.S. Army Corps of Engineers, SPILL, "Spatially Varied Flow-Analysis," Users Manual, USED, St. Paul District, July 1980 (Draft).
2. Chow, Ven Te, "Open Channel Hydraulics," McGraw-Hill Book Company, 1959.
3. King and Brater, "Handbook of Hydraulics," McGraw-Hill Book Company, Fifth Edition, 1963.
4. Kindsvater, Carl E., "Discharge Characteristics of Embankment-Shaped Weirs," USGS Water Supply Paper 1616A, 1964.
5. U.S. Army Corps of Engineers, HEC-2 "Water Surface Profiles " Users Manual, The Hydrologic Engineering Center, August 1979.
6. EM 1110-2-1601, Hydraulic Design of Flood Control Channels.
7. EB 54-15, Improvements in Design and Construction in Civil Works.

EXISTING CONDITIONS

GENERAL

As stated above, the effects of the many possible modes of levee failure were analyzed. The assumed existing levee conditions will be identified by number throughout this report as follows:

1. All flow confined within the levees (levees hold).
2. The levees are overtopped but do not breach or fail.
3. No levees (total levee failure).
4. Complete failure of the Caledonia and Lewiston levees with Portage holding.
5. Complete failure of the Portage levees with Caledonia and Lewiston holding.
6. Portage levee holds. Lewiston levee holds. Caledonia levees fail completely.
7. Portage levee holds. Caledonia levee holds. Lewiston levees fail completely.
8. Portage levees fail completely. Caledonia levees fail completely. Lewiston levee holds.
9. Portage levees fail completely. Lewiston levees fail completely. Caledonia levee holds.

A detailed analysis of the Wisconsin River floodplain from the Prairie du Sac Dam to Wisconsin Dells for levee condition 1 through 5 was completed for this study and pertinent results of that detailed study are summarized herein (see Plate C-1).

The plates referred to in this paragraph were developed for the detailed analysis of levee conditions 1 through 5. Plates C-2 and C-3 are the index sheets for locations of plates showing floodplain delineation. Plates C-4, C-5 and C-6 show in schematic form the overflow locations for assumed levee conditions 1, 2 and 3. Floodplain mapping and profiles are shown for assumed existing levee conditions 1) - 3) on Plates C-7 - C-29 and C-30 - C-36, respectively. Plates C-37 and C-38 show in schematic form the overflow locations for breach conditions 4 and 5. Floodplain mapping and profiles are shown for assumed existing levee conditions 4 and 5 on Plates C-39 - C-61 and C-62 - C-68, respectively.

Previous studies of the Wisconsin River floodplain have not considered the two-dimensional nature of the flood flows. This study attempts to account for the lateral gradient in flow rather than assuming that the channel water surface elevation extends horizontally in the lateral direction from the stream until the water surface elevation intersects high ground. Accounting for this lateral gradient in flow can result in reduced discharges and thus stages on the Wisconsin River. Similarly the storage areas are analyzed as independent systems, thereby, reduction in flood elevations (routing) and outflow to the Fox or Baraboo Rivers are considered.

Levee conditions 6, 7, 8 and 9 were not sutdied in detail. Both in the interest of time and computer expense, engineering judgment was used to modify computer runs and backup data developed in the detailed study of levee conditions 1 through 5 to determine a reasonable representation of these four modes of levee failure. See Hydraulic Analysis Techniques section for discussion of method of analysis, profiles, etc. for these modes of levee failure.

HYDRAULIC ANALYSIS TECHNIQUES

Baraboo River

Valley and bridge cross section data, obtained from field surveys, was used to develop a hydraulic model of the Baraboo River. Locations of cross sections used in the hydraulic analysis are shown on Plates C-16, C-17, C-18 and C-26. The available mapping for the area is from USGS quadrangles.

Roughness factors (Manning's "n" values) for these computations were assigned on the basis of field inspection of the floodplain areas.

Floodway boundaries were based on the topography of the area and on the constrictions imposed by flow through the bridges.

From the Baraboo River mouth upstream approximately 4.5 miles, the water surface profile is controlled by the starting stage on the Wisconsin River. The profile for a given frequency is computed using the Wisconsin River stage at the mouth of the Baraboo for the coincident discharge of the same frequency occurring on the Baraboo River. Upstream of the point where the Wisconsin River backwater controls, the Baraboo River profile was computed using the Baraboo River frequency-discharge relationships. In this second reach, the water surface elevation used at the mouth of the Baraboo River has little effect on the water surface profile obtained. The above discussed simplified procedure was used in lieu of a bivariate analysis of stage in the lower reaches of the Baraboo River due to the dominant effect of the Wisconsin River on stage in the lower reaches of the Baraboo.

For assumed levee conditions 3 and 4 on the Wisconsin River, the Baraboo River water surface profile from the mouth to Highway I-90-94 is totally determined by the Wisconsin River profile. For these conditions the Wisconsin River floodway extends beyond the Baraboo River. Upstream of Highway I90-94 the Wisconsin River floodway does not encroach upon the Baraboo River due to the highway embankments. Upstream of I-90-94 the Barabroo River profile was computed using the Baraboo River frequency-discharge relationship.

Neenah Creek

Neenah Creek is a tributary to the Fox River. The cross sections used to model this tributary extend from its mouth upstream to its confluence with Big Slough. The cross section data continues up the Big Slough tributary a distance of approximately 12,900 feet from the Neenah Creek confluence. The locations of the cross sections used in the hydraulic analysis are shown on Plates C-10, C-11 and C-12. The cross sections were field surveyed in 1979 by Owen Ayres and Associates, Inc. Mapping for the area is limited to USGS quadrangles.

Roughness factors (Manning's "n" values) for this model were assigned on the basis of field inspecting the floodplain areas. In almost all cases, the roughness coefficients for the outer overbanks will be less than that in the immediate overbanks. The area is largely wetland, with heavy vegetation only on the immediate banks. Composite typical roughness values for the overbanks have been used in most cases.

Starting water surface elevations for Neenah Creek's various frequency floodway computations were developed using the slope area method since the Fox River water surface profile corresponding frequency was not used. It was not possible to assign the Fox River basin exceedance frequencies to Neenah Creek discharges since the source of these discharges is considered to be Wisconsin River overflow. However, for floodplain delineation for the area the higher water surface of Fox River or Neenah Creek was used.

Because the Wisconsin River is considered to be the major source of discharges through Neenah Creek and Big Slough for extreme flood events, a constant discharge was used throughout the entire reach studied for existing condition floodway computations. The discharges were not changed at the confluence of Neenah Creek and Big Slough. Floodway boundaries defining the effective flow widths were based on the topography of the area and on the constrictions imposed by flow through bridges.

Wisconsin River

Hydraulic analysis of the Wisconsin River was carried out, for the feasibility study, in three reaches as follows:

1. Prairie du Sac Dam to the Interstate 90-94 bridge.
2. Interstate 90-94 bridge to the Sauk-Columbia County line.
3. Sauk-Columbia County line to Wisconsin Dells.

The HEC-2 input data for Reach 1 were based on field surveys by the St. Paul District, Corps of Engineers. The HEC-2 input data for Reach 2 were obtained from the Wisconsin Department of Natural Resources. Sections AI and AM were surveyed by Owen Ayres and Associates, Inc. and added to the second reach. The HEC-2 input data for the third reach were obtained from the Wisconsin Department of Natural Resources.

Historic data were used to calibrate the HEC-2 model for Levee Condition 1 at the Portage gage. Levee Condition 1 (all flows confined within the levee) is the condition applicable for calibration of the HEC-2 model to the observed elevation discharge data as most or all of the flow was contained by the Lewiston, Caledonia and Portage levees for the historic floods of record since construction of the levees. Plate 102 shows the elevation discharge rating curve at the Portage gage for Levee Condition 1 as well as observed elevation discharge data.

SPATIALLY-VARIED-FLOW HYDRAULICS

In order to properly analyze Wisconsin River flood characteristics, spatially-varied-flow (SVF) techniques were used. A spatially varied flow analysis was required because of the interbasin flow that can occur from the Wisconsin to the Fox and Baraboo Rivers. Discharges over the levees and embankments along the Wisconsin River were calculated using the "SPILL" program (reference 1) developed by the St. Paul District Corps of Engineers. The "SPILL" model performs standard step backwater computations while simultaneously calculating lateral outflow over levees. Using the "SPILL" model, the SVF analyses required to compute the effects of floods on the Wisconsin River were performed. Water surface profile computations accomplished by the computer program "SPILL" are based on equation 12-40 as presented in reference 2. The equation was developed for spatially varied flow with decreasing discharge. For application in the SPILL computer program, the equation was modified to include the effect of expansion and contraction losses. The modified form of the equation as used in the SPILL computer program is as follows:

$$\Delta y' = \frac{\alpha Q_1 (V_1 + V_2) \Delta V}{g(Q_1 + Q_2)} \left[1 - \frac{\Delta Q}{2Q_1} + he \right]$$

where:

$\Delta y'$ = the difference in water surface elevations between the upstream and downstream sections

Q_1 = the channel discharge at section 1

Q_2 = the channel discharge at section 2

V_1 = the channel velocity at section 1

V_2 = the channel velocity at section 2

α = the kinetic energy correction factor

g = acceleration of gravity

ΔV = $V_2 - V_1$

ΔQ = $(Q_2 - Q_1) = \Delta Q_{left} + \Delta Q_{right}$ = the lateral outflow

he = total energy headloss

The prediction of lateral outflow or the ΔQ term in the equation is based on the assumption that the levee or embankment controlling the lateral outflow can be treated as a weir. Weir flow computations performed by the SPILL computer program are based on equation 5-10 in reference 3. The equation follows:

$$Q = CLH^{3/2}$$

where:

Q = lateral discharge (cfs)

C = weir discharge coefficient (adjusted to include effect of velocity of approaching the effect of non-normal flow over levees; the shallow depth of flow, if applicable; the shape of the levees; the top width of the levees; the roughness of the levees; and the effect of submergence, if applicable)

L = weir length (feet)

H = depth of flow above the weir

For application in the SPILL computer program, the above equation was modified as presented below:

$$\Delta Q_L = C_L A_L \left[\frac{A_L}{L_L}\right]^{\frac{1}{2}}$$

$$\Delta Q_R = C_R A_R \left[\frac{A_R}{L_R}\right]^{\frac{1}{2}}$$

$$\Delta Q = \Delta Q_L + \Delta Q_R$$

where:

ΔQ_L = lateral outflow to the left

ΔQ_R = lateral outflow to the right

ΔQ = total lateral outflow from the reach

C_L, C_R = discharge coefficients for the left and right weirs

A_L, A_R = flow areas above the top of the left and right levees between sections 1 and 2

L_L, L_R = total horizontal lengths of water surface above the inundated left and right levees between section 1 and 2

Total energy head loss in a reach is computed by:

$$h_e = L\bar{S}_f + C_k \left[\frac{\alpha_2 V_2^2}{2g} - \frac{\alpha_1 V_1^2}{2g}\right]$$

where:

$\bar{S}_f$ = representative friction slope for the reach

L = discharge weighted reach length

C_k = expansion or contraction loss coefficient

$$L = \frac{XLOBL*\overline{QLOB} + XLCH*\overline{QCH} + XLOBR*\overline{QROB}}{\overline{Q}}$$

XLOBL, XLCH, XLOBR = Reach lenghts specified for flow in the left overbank, channel, and right overbank, respectively

$\overline{QLOB}$, $\overline{QCH}$, $\overline{QROB}$ = arithmetic average of flows at the ends of the reach for the left overbank, channel and right overbank, respectively

$\overline{Q}$ = arithmetic average of total flow at the ends of the reach

The determination of total conveyance in a cross section is different from that of HEC-2, that is, there is a difference in the method of subdivision in the computation of overbank conveyance.

The total conveyance in a cross section may be determined by:

$$K = k_{lob} + k_{ch} + k_{rob}$$

Conveyance for channel area:

$$k_{ch} = \sum_{i+1}^{N} k_i$$

where: N = number of horizontal roughness factor variations in the channel area

Conveyance for overbank area:

$$k_{lob} = \sum_{i=1}^{NL} k_i$$

$$k_{rob} = \sum_{i=1}^{N} ki$$

where: NL, NR = (a) <u>"SPILL" method</u>
number of horizontal roughness factor variations in the left and right overbank area, respectively.

(b) <u>"HEC-2" method</u>
number of "GR" station intervals in the left and right overbank area, respectively.

Conveyance for each subdivided area:

$$k_i = \frac{1.486}{n_i} \quad a_i r_i^{2/3}$$

where: n_i = roughness factor for ith subsection

a_i = flow area for ith subsection

r_i = hydraulic radius for ith subsection

Kinetic energy correction factor α is computed as follows:

Method 1 (HEC-2 method):

$$= \frac{QLOB*(VLOB)^2 + QCH*(VCH)^2 + QROB*(VROB)^2}{QV^2}$$

where: QLOB, QCH, QROB = discharges in the left overbank, channel and the right overbank, respectively.

VLOB, VCH, VROB = flow velocities for the left overbank, channel, and the right overbank, respectively.

Friction loss computation is the same as that of HEC-2. All four equations for the representative friction slope in a reach, described in HEC-2 manual, and one additional equation are available in SPILL program. The average conveyance equation used for this study is presented below:

$$\bar{S}_f = \left[\frac{Q_1 + Q_2}{K_1 + K_2}\right]^2$$

The program SPILL was used to determine the relationships among stage and discharge in the main channel and spill discharge to the left and/or right overbanks at various locations along the main channel.

CALIBRATION OF THE SPILL MODEL

Prior to using the "SPILL" program to model the floods on the Wisconsin River, it was tested and calibrated. First, an analysis of the weir coefficient used in "SPILL" was done. This analysis was done to determine a proper value of the weir coefficient and the sensitivity of the selection. Then the "SPILL" model was calibrated by modifying its input parameters so that the water surface profiles from "SPILL" assuming no levee overflow, and HEC-2 were in close agreement.

A literature search was conducted to determine the effects on the weir coefficient of the following flow conditions: 1) the non-normal flow over the levees; 2) the shallow depth of flow over the levees; 3) the shape of the levees; 4) the top width of the levees; 5) the roughness of the levees; 6) the "SPILL" program considered the unsteady flow field as a steady-state pool; and 7) the effect of possible submergence of the levees on the amount of overflow. A modification factor K was introduced to quantify the effects of non-normality and roughness. Calculation of K showed that a reduction in the weir coefficients from those listed by King (reference 3) was warranted. A value of 2.4 was used for KC for weirs under free-flow conditions. This value reflected considerations given to the effects of the above on the overflow.

In addition to the above, a portion of the Wisconsin River near Portage was modeled with the "SPILL" program using values of the product KC of 2.4, 2.0 and 1.7, to determine the effect of the weir coefficient KC on spill flow. This analysis showed, for a discharge of 50,000 cfs upstream of the spill area, that by changing the modified weir coefficient from 2.4 to 2.0 decreases the spill flow from 15,410 cfs to 12,440 cfs or 20%. Using KC = 1.7, the spill flow is reduced to 10,370 cfs, or a 33% reduction. A discharge of 50,000 (which has a 5-year return period) was selected for illustrative purposes because it made judging the reasonableness of the spill flows easier. Determining the reasonableness of the results from less frequent events would be more difficult.

The "SPILL" model was then compared to the results from an HEC-2 backwater model using the discharges from "SPILL." The HEC-2 profile was considered the standard because of its ability to consider variable "n" values across a section and head losses at bridges, thus the "SPILL" model parameters were changed to achieve similarity with the HEC-2 profile.

Four input parameters to the "SPILL" model were considered when fitting the "SPILL" results to the HEC-2 results. The four parameters were: 1) Manning's "n"; 2) the expansion coefficient; 3) the contraction coefficient; and 4) bridge losses. The expansion and contraction coefficients used were 0.3 and 0.1, respectively, as recommended in the HEC-2 user's manual. These values remained constant for all the simulations. Manning's "n" was the only parameter varied, and the results compared.

Bridge losses were input to "SPILL" by using X5 cards and the discharge versus head loss curves developed from HEC-2 runs as shown on Plate C-69.

Based on these comparisons the following parameters were used: Manning's "n" = 0.042 Section AD to AV; Manning's "n" = 0.030 Section AV to BK; Expansion coefficient (CEHV) = 0.3; Contraction coefficient (CCHV) = 0.1; Bridge losses: (for Q = 85,000 cfs) through S.T.H. 33 - 1.1 feet and through S.T.H. 78 - 0.5 foot.

For the spatially-varied-flow analyses of the assumed levee conditions, different levee geometries were used in the "SPILL" model. For the condition where levees are overtopped but do not breach or fail (condition 2), the centerline elevations of the existing levees were used.

For reaches where there are no levees or gaps in existing levees, roads or high ground were used as the overflow embankments. Where two roads parallel the river in locations where there are no levees, the highest road elevations were assumed to control. Due to their elevation, railroad tracks could act as the embankment in some locations. However, due to the porosity of the railroad ballast, and its susceptibility to erosion, it was decided that the railroad berm would not be an effective embankment. Plates C-70, C-71, C-72 and C-73 show the levee configurations used for assumed levee condition 2, 3, 4 and 5, respectively.

WISCONSIN RIVER FLOOD ROUTING

Using results from SPILL model runs, curves of APPRCHQ vs. SPILLQ for each reach were developed for three cases; KC = 2.7; KC = 2.4; and KC = 2.0. A typical one of these graphs is shown on Plate C-74. A computer program was written that uses these curves to route an input hydrograph downstream. The program takes the discharge at the first time interval at the upstream section, uses it as an approach discharge, and determines the spill flow by interpolating the APPRCHQ vs. SPILLQ curve for the reach. The approach discharge to the next downstream section is the approach discharge at the current section minus the spill discharge for the reach. Then the program uses the discharge at the next time on the hydrograph as an approach discharge to the upstream section and performs another interpolation. In this way the program proceeds through time and down the river routing the input hydrograph.

ROUTING LEVEE OVERFLOW OR LEVEE FAILURE FLOWS

Table C-1 indicates the locations of levee overflow or levee failure flow for levee conditions one through five.

TABLE C-1

LOCATION OF OVERFLOW OR LEVEE FAILURE FLOWS

	Caledonia Overflow Area	Lewiston Levee	Portage Levees
1. All flow confined within levees	-	-	-
2. Levees overtopped but do not fail	100 yr. SPF	100 yr. SPF	100 yr. SPF
3. No levees	100 yr. SPF	100 yr. SPF	100 yr. SPF
4. Complete failure of the Caledonia and Lewiston levees with Portage holding	100 yr. SPF	100 yr. SPF	- SPF
5. Complete failure of the Portage levee with Caledonia and Lewiston holding	100 yr. SPF	100 yr. SPF	100 yr. SPF

For levee conditions 2, 3, 4 and 5, Wisconsin River overflows were routed using the modified Puls method through pseudo-reservoirs in Lewiston, Caledonia and Pacific townships. For conditions 2 and 5 routing in the Lewiston area was done through two reservoirs in series, with their division at Wisconsin Highway 16. Routing through two reservoirs gave a better representation of the actual flow through the area than routing through only one.

The first Lewiston reservoir is bounded by Columbia County Highway O in the south, S.T.H. 16 in the north and high ground in sections 34 and 31 in the east and west respectively. The second Lewiston reservoir is bound by S.T.H. 16 in the south, a constricted flow section on Big Slough in the north, Klapstein Road in the west and high ground in sections 24 and 25 in the east. Elevation-storage relationships for these reservoirs are shown on Plate C-75.

In Caledonia township, the reservoir is bounded by Wisconsin River levees in the north, Wisconsin 33 in the south, S.T.H. 78 in the east and high ground in the west. The elevation-storage relationship for this reservoir is shown on Plate C-76.

In Pacific township the Fox River Swamp reservoir is bounded by a constriction of the Fox River caused by S.T.H. 33 on the north and high ground separating Duck Creek from the Fox on the south. The eastern boundary has high ground near Pardeeville and on the west the reservoir is bounded by U.S. 51. The elevation-storage relationship for this reservoir is shown on Plate C-77.

A rating curve for flow over S.T.H. 16 was used as the elevation-discharge relationship for the first Lewiston reservoir. A rating curve for discharge through a constricted section of Big Slough in section 9 of Lewiston township was used as the elevation-discharge relationship for the second Lewiston reservoir. These relationships are shown on Plate C-78.

A rating curve was developed for road overflow on S.T.H. 33 and was used as the elevation-discharge relationship for the first Caledonia reservoir. Plate C-79 shows this relationship.

A rating curve for discharge through the S.T.H. 33 bridge over the Fox was developed using the HEC-2 model for the Fox. This rating curve was used as the elevation-discharge relationship for the Fox River Swamp reservoir and is shown on Plate C-80.

For levee conditions 3 and 5 a special procedure to compute Wisconsin River discharge and inflow to and outflow from Fox River Swamp reservoir simultaneously was developed. The special procedure was necessary because of submergence of the weir between the Wisconsin River and Fox River Swamp reservoir, and the likelihood of backflow from the reservoir to the Wisconsin River when the Wisconsin River recedes.

First, rating curves at section AG of the Wisconsin River were developed for different values of KC. Plate C-81 shows the rating curves for various KC values starting to diverge at 60,000 cfs. This indicates that, up to 60,000 cfs, stage is solely a function of river discharge, and that above 60,000 cfs, stage is a function of both river discharge and levee overflow. Since spillage for condition 5 begins at approximately 20,000 cfs, it was assumed that Wisconsin River stage at section AG is independent of KC for all frequencies. Because spillage for condition 3 begins at 45,000 cfs it was assumed that Wisconsin River stage would be dependent on both KC and Wisconsin River discharge for all frequencies. Therefore, different methods were used to find the inflow and outflow for Fox River Swamp reservoir.

For both conditions 3 and 5 the "SPILL" model was run for a variety of KC values to develop a set of approach Q vs. spill Q curves. Plate C-82 shows these curves. Kindsvater (reference 4) related the weir coefficient to the degree of submergence. The curves shown on Plate C-82 were used to determine the overflow into the Fox River Swamp reservoir; these curves account for submergence.

A program that routed floods through channels with lateral overflow was run for the 2-, 10-, 25-, 50-, 100-, 200- and 500-year frequency and standard project floods. Overflows in the reach between sections AE and AN were predicted for free-flow conditions. These overflows were then routed through the Fox River Swamp reservoir using a specially adapted version of a reservoir routing program which accounted for the degree of submergence between the Wisconsin River and Fox River Swamp reservoir. The reservoir routing program had several unique features added to it. At every time step it calculated the stage in the Wisconsin River from an input discharge and the rating curve shown on Plate C-81. Then it calculated the degree of submergence between the river and the reservoir. The average height of the levee in the overflow reach was determined by using the procedure established for submergence checks for other conditions. The average height of the levee was 788.4 feet.

At each time step, the reservoir routing program performed the routing, calculated the Wisconsin River stage, and the degree of submergence. For degrees of submergence less than 0.9, the computations proceeded to the next time, without any modification of inflow to the reservoir. Kindsvater (reference 4) showed that for submergences less than 0.9, no appreciable reduction in overflow exists. When submergences were greater than 0.9, a new inflow value was input. The new input value was selected from Plate C-82 using a reduced KC coefficient to account for the submergence. The weir coefficient versus degree of submergence from Kindsvater (reference 4) and shown in Figure C-1 was used to select the submerged weir coefficient. Then the Wisconsin River discharge was changed to maintain continuity in the river/reservoir system.

With this procedure, inflows to Fox River Swamp reservoir under submerged conditions were computed.

For condition 3, submergence occurred only for the 500-year and SPF. The method used was similar to that used for condition 5 except that the routing was done by hand and that KC value was considered in determining Wisconsin River stage.

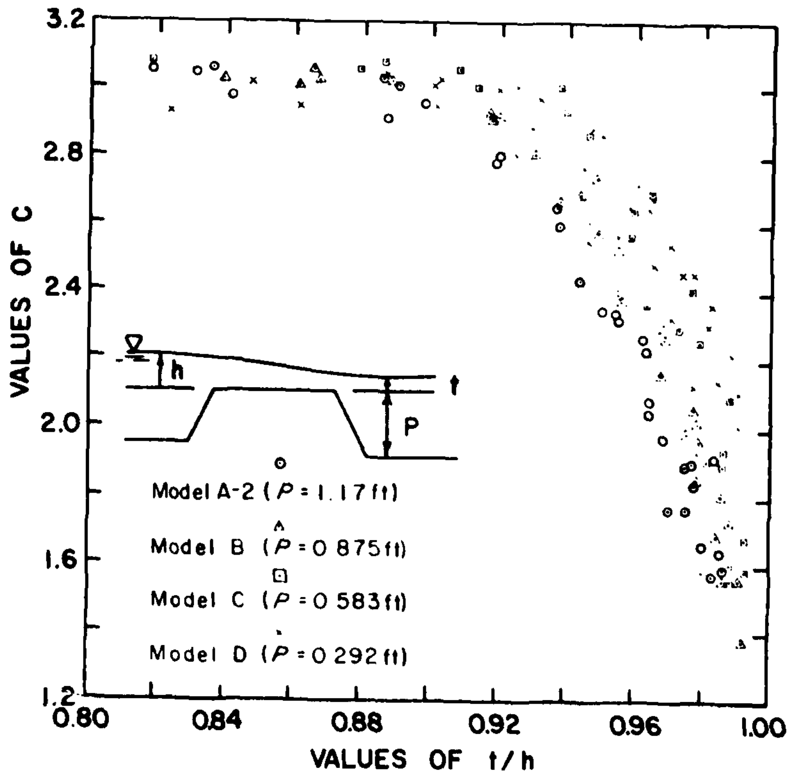


Figure C-1 Coefficient of Discharge for Submerged Flow (from reference 4)

FLOODPLAIN MAPS

This study used available topographic mapping for outlining the floodway and floodplain for the alternative levee conditions discussed in the following paragraphs. Table C-2 lists the U.S. Geological Survey quadrangle maps used in this study. These maps were used for Plates C-7 to C-18, C-26 to C-29, C-39 to C-50, and C-58 to C-61.

TABLE C-2
U.S. GEOLOGICAL SURVEY QUADRANGLE MAPS
USED FOR FLOODWAY/FLOODPLAIN DELINEATION

Name	Date	Scale	Series	Contour Interval
Baraboo NE	1974	1:24000	7.5 min.	10 ft.
Baraboo NW	1974	1:24000	7.5	10
Baraboo SE	1974	1:24000	7.5	10
Baraboo SW	1974	1:24000	7.5	10
Lewiston	1975	1:24000	7.5	10
Pine Island	1975	1:24000	7.5	10
Portage SE	Advance	1:24000	7.5	10
Portage SW	Advance	1:24000	7.5	10
Poynette NW	Advance	1:24000	7.5	10
Wisconsin Dells NE	1975	1:24000	7.5	10
Wisconsin Dells SE	1975	1:24000	7.5	10

For the city of Portage, 2-foot contour interval maps at 1" = 100' dated 1957 were used. Plates C-19 to C-25 and C-51 to C-57 are based on these maps.

The delineation of the floodway/floodplain was checked by field surveys (spot elevations).

ASSUMED EXISTING LEVEE CONDITION 1 (ALL FLOW CONFINED WITHIN THE LEVEES)

For the assumed existing levee condition in which all flow is confined within the levees, the water surface profiles for Reaches 1, 2 and 3 were modeled using only HEC-2 (reference 5) since there was no lateral outflow for this condition. Levees at all locations were assumed not to fail and

to remain stable at their present alignment. Analysis of this assumed existing levee condition required that artifical levees be placed in cross sections where actual levees did not exist to contain the flow. Artifical levees were placed at roadway embankments where this provided for a hydraulic floodway having smooth transitions. Where roadways or other physical barriers did not exist, artifical levees were placed to allow for smooth transitions in the hydraulic floodway in order to represent a logical alignment required to contain flood flows in areas where levees do not currently exist. Interior drainage flooding due to surface runoff from interior drainage basins and seepage from the Wisconsin River would cause some flooding on the landward side of the levee which may require interior drainage pumping stations. Backwater from the Wisconsin River could occur landward of levees through Duck Creek and Baraboo River flooding. Refer to Plates C-30 through C-36 for the water surface profiles and Plates C-7 through C-29 for the floodplain mapping. Water surface elevations at selected locations for this alternative are given in Table C-3.

TABLE C-3
WATER SURFACE ELEVATION AT SELECTED LOCATIONS
FOR ASSUMED EXISTING LEVEE CONDITION 1

	Water Surface Elevations	
	100-Yr.	SPF
Wisconsin Dells Gage	825.8	832.5
Section AY U/S limit of overflow	805.1	812.4
Portage Lock	796.1	800.6
Section AD D/S limit of overflow	791.4	795.8
Baraboo confluence	789.9	794.0
I-90-94 Bridge	782.3	785.5
Prairie du Sac Dam	774.0	774.0

ASSUMED EXISTING LEVEE CONDITION 2 (LEVEES OVERTOPPED BUT DO NOT FAIL)

For the assumed existing levee condition in which flow is allowed to overtop the levees without levee failure, water surface profiles for Reaches 1 and 3 were modeled using HEC-2 and Reach 2 was modeled using "SPILL" calibrated to HEC-2. "SPILL" was calibrated to HEC-2 to account indirectly for variable roughness factors across a given cross section. Levees at all locations for this assumed existing levee condition was assumed to remain stable at present elevations throughout the occurrence of the 100-year frequency and standard project floods. Changes in flood discharges upstream of the Baraboo River and Duck Creek confluences with the Wisconsin River were developed using a bivariate statistical analysis discussed in detail in Appendix B. Refer to Plate C-5 for a flow schematic diagram of this assumed existing levee condition giving the numbers of plates containing pertinent information. Plates C-30 through C-36 show the water surface profiles and Plates C-7 through C-29 the floodplain mapping. Water surface elevations at selected locations for this alternative are given in Table C-4.

TABLE C-4
WATER SURFACE ELEVATIONS AT SELECTED LOCATIONS
FOR ASSUMED EXISTING LEVEE CONDITION 2

	Water Surface Elevations	
	100-Yr.	SPF
Wisconsin Dells gage	825.8	832.5
Section AY (U/S limit of overflow)	803.1	805.2
Portage Lock	795.4	795.8
Section AD (D/S limit of overflow)	790.2	790.8
Baraboo confluence	789.2	789.4
I-90-94 Bridge	781.6	781.8
Prairie du Sac Dam	774.0	774.0

For this levee condition, spillage over the Portage levee for the 100-year flood occurred primarily between sections AD and AE. This overflow splits, with approximately one-third of it backflowing into Duck Creek, and two-thirds entering the Fox River Swamp reservoir. For the reach from AD

to AE the depth of flow over the levee was 0.3 foot and the length of the overflow was approximately 600 feet. A small amount of overflow occurred between se tions AE and AF. Here the depth over the levee was 0.4 foot, and the length of flow over the levee was approximately 160 feet. For the SPF, most of the overflow in the Portage area occurred in the reach between sections AD and AE. Again, approximately one-third of this overflow went into Duck Creek. The depth of flow over the levee was 0.6 foot and the length was approximately 1,500 feet. A less amount of overflow occurred between sections AE and AF. Here the depth and length of overflow were approximately 0.8 foot and 450 feet, respectively.

Overflow into the Lewiston reservoirs occurred primarily in the reach between sections AS and AU. The depth and length of the overflow were approximately 1.0 foot and 2,300 feet, respectively for the 100-year flood. For the SPF the depth and length were approximately 2.0 feet and 2,700 feet respectively.

The Caledonia reservoir received Wisconsin River overflows in the reach between sections AO and AS. For the 100-year flood, the depth of the overflow was approximately 0.3 foot and the total length was approximately 5,300 feet. For the SPF, the approximate depth and length were 1.0 foot and 11,000 feet, respectively.

Inflow/outflow hydrographs for the first and second Lewiston reservoirs for the 100-year and standard project floods for levee condition 2 are shown on Plate C-83. For the SPF, the overflow was routed through a composite of the first and second Lewiston reservoirs. This was necessary due to the large inflow and the instabilities it created when routing through each reservoir sequentially.

At the 100-year flood, the total volume of spillage into the Lewiston reservoirs from the Wisconsin River was approximately 26,000 acre/feet. Approximately 8 days were required to completely route the overflow

through the reservoirs. The peak stages in the reservoirs were 798 and 792 feet above MSL in the first and second reservoirs, respectively. The depth of flow over Columbia C.T.H. O where it intersects cross section AT was approximately 2 feet. As the water progressed northward, it crossed U.S. Highway 16 at a depth of approximately 0.5 foot. At the SPF, the volume of spillage into Lewiston was approximately 250,000 acre/feet and approximately 10.5 days were required for complete routing. The peak stage in the composite reservoir was 801. The depth of flow over Columbia C.T.H. O at section AT was approximately 3 feet.

The levee condition 2 hydrographs for the Caledonia reservoir are shown on Plate C-84. Approximately 5,000 acre/feet of water spilled into the Caledonia reservoir during the 100-year flood and was routed out in approximately 3.5 days. The peak stage in the reservoir was 794. The maximum depth of flow out of the reservoir over Wisconsin S.T.H. 33 was approximately 0.2 foot.

During the SPF, approximately 68,000 acre/feet of spillage occurred. During this event, the reservoir behaved like an effective flow area between the location of Wisconsin River overflow and the Baraboo River. Attenuation in the reservoir was negligible and the overflow passed through the reservoir in approximately 6 days. The peak stage in the reservoir was approximately 795, and the maximum depth of flow over Wisconsin S.T.H. 33 was approximately 1.2 feet.

Plate C-85 shows the levee condition 2 hydrographs for the Fox River Swamp reservoir. At the 100-year flood, the spillage was approximately 500 acre/feet and almost 14 days were required to route this spillage. The peak stage in the reservoir for this overflow was only 0.1 foot higher than that for an empty reservoir. Considering the topography in the area, this rise would be imperceptible. The peak depth of flow over U.S. Highway 51 was approximately 0.2 foot.

At the SPF, the spillage was approximately 4,000 acre/feet and approximately 23 days were required for complete routing. The peak stage in the reservoir was 799, or 0.8 foot higher than an empty reservoir. The peak depth of flow over U.S. Highway 51 was approximately 0.5 foot.

ASSUMED LEVEE CONDITION 3 (NO LEVEES)

For the assumed levee condition in which the floodplain is modeled as though there were no levees in place, the "SPILL" model was used after calibration to HEC-2 to analyze the large lateral outflow component from the river. "SPILL" was first calibrated to HEC-2 to account indirectly for variable roughness factors across a given cross section. Interbasin flow to the Fox River begins at a Wisconsin River discharge of approximately 45,000 cfs having an exceedance probability of approximately 0.24. Interbasin flow to the Fox River begins at higher Wisconsin River discharge for levee condition 3 than for levee condition 5 because the Wisconsin River floodway is much less constricted for levee condition 3 resulting in lower Wisconsin River channel stages for a given discharge. Lateral outflow hydrographs away from the Wisconsin River were determined for the 100-year and standard project floods in the general areas of Lewiston and Portage. These levee overflow hydrographs were routed through their respective storage areas to determine outflow hydrographs to the Fox River and Neenah Creek. The bivariate analysis discussed in detail in Appendix B was used to develop a frequency-discharge relationship downstream of the Neenah Creek-Fox River confluence that accounts for Wisconsin River interbasin flow. Changes in flood discharges upstream of the Baraboo River and Duck Creek confluences with the Wisconsin River were developed using a bivariate statistical analysis discussed in detail in Appendix B. Interior surface runoff from interior drainage basins and seepage from the Wisconsin River would cause some localized flooding on the landward side of some physical barriers to flow such as highway and railroad embankments, however, the existing cross drainage structures through these embankments would probably provide adequate drainage. Refer to

Plate C-6 for a flow schematic diagram of this assumed existing levee condition giving the numbers of plates containing pertinent information. Refer to Plates C-30 through C-36 for the water surface profiles and Plates C-7 through C-29 for the floodplain mapping. Water surface elevations at selected locations on the river for this alternative are given in Table C-5.

TABLE C-5
WATER SURFACE ELEVATIONS AT SELECTED LOCATIONS
FOR ASSUMED LEVEE CONDITION 3

	Water Surface Elevations	
	100-Year	SPF
Wisconsin Dells Gage	825.4	831.9
Section AY (U/S limit of overflow)	803.1	804.4
Portage Lock	791.6	792.4*
Section AD (D/S limit of overflow)	788.7	790.7
Baraboo confluence	787.5	789.5
I-90-94 Bridge	780.8	782.2
Prairie du Sac Dam	774.0	774.0

*Approximate due to specialized computations that accounted for submergence.

During the 100-year flood, overflow into the second Lewiston reservoir occurred between sections AT and AY. The embankment used in this reach in the "SPILL" model was U.S. Highway 16. The average depth of flow over the highway was approximately 0.4 foot, and the length of overflow totalled approximately 8,600 feet. During the SPF, overflow occurred between sections AT and AY. The average depth of flow over U.S. Highway 16 was approximately 1.4 feet, and the length of overflow was approximately 9,700 feet.

For this levee condition, there was a substantial amount of overflow into the city of Portage between sections AF and AI. The embankment used as a levee in the "SPILL" model in this reach was U.S. Highway 51. For the 100-year flood, depths of flow over the highway averaged 0.8 foot. The total length of flow passing over the highway for this flood was approximately 8,800 feet.

During the SPF, the U.S. Highway 51 embankment became submerged and the special computational procedure for this condition that was explained in the section "Routing Levee Overflow or Levee Failure Flow" was used. This procedure yielded approximations for the amount of overflow, but not depths or lengths of overflow. Based on the overflows that occurred during the 100-year flood when there was no submergence, estimates of the depth and length of overflow for the SPF were made. At the time of peak overflow, thd depth and length of the overflow were estimated to be 1.4 and 9,000 feet, respectively.

Plate C-86 shows the hydrographs for the second Lewiston reservoir for this levee condition. At the 100-year flood, approximately 24,000 acre/feet of spillage into the reservoir occurred, and it took approximately 6 days to route it through. The peak stage in the reservoir during the 100-year flood was approximately 792. During the SPF, the spillage was approximately 200,000 acre/feet and approximately 10 days were required for complete routing. The peak stage in the reservoir was approximately 800.

The hydrographs for levee condition 3 for the Fox River Swamp reservoir are shown on Plate C-87. The volume of spillage during the 100-year flood was approximately 85,000 acre/feet and complete routing required approximately 9.5 days. The peak stage in the reservoir was approximately 789. Spillage during the SPF was estimated to 110,000 acre/feet before the weir became submerged. Due to the possibility of the reservoir flowing back into the Wisconsin as well as down the Fox after submergence, the time required to route the spillage was not computed. The peak stage in the reservoir was approximately 792. Flooding on the Fox could cause an increase in this stage.

ASSUMED LEVEE CONDITION 4 (COMPLETE FAILURE OF THE CALEDONIA AND LEWISTON LEVEES WITH PORTAGE HOLDING)

For this assumed levee condition, the water surface profile in reaches 1 and 3 was modeled using HEC-2. The water surface profile in reach 2 was modeled using "SPILL" calibrated to HEC-2 to account indirectly for variable roughness factors across a given cross section. Interbasin flow to the Fox River begins at a Wisconsin River discharge of approximately 63,000 cfs having an exceedance probability of approximately 0.05. Levee overflow hydrographs away from the Wisconsin River were determined for the 100-year and standard project floods over the Lewiston and Portage levees. These levee overflow hydrographs were routed through their respective storage areas to determine outflow hydrographs to the Fox River and Neenah Creek. The bivariate analysis discussed in detail in Appendix B was used to develop a frequency-discharge relationship below the Neenah Creek-Fox River confluence that accounts for Wisconsin River interbasin flow. Changes in flood discharge upstream of the Baraboo River and Duck Creek confluence with the Wisconsin River were developed using a bivariate statistical analysis discussed in detail in Appendix B. Interior drainage flooding due to surface runoff from interior drainage basins and seepage from the Wisconsin River would cause some flooding on the landward side of the Portage levee which may require interior drainage pumping stations. Refer to Plate C-37 for a flow schematic diagram of this assumed existing levee condition giving the numbers of plates containing pertinent information. Refer to Plates C-62 through C-68 for the water surface profiles and Plates C-39 through C-61 for the floodplain mapping. Water surface elevations at selected locations for this assumed existing levee condition are given in Table C-6.

TABLE C-6
WATER SURFACE ELEVATIONS AT SELECTED LOCATIONS FOR ASSUMED LEVEE CONDITION 4

	Water Surface Elevations	
	100-Year	SPF
Wisconsin Dells Gage	825.4	831.9
Section AY (U/S limit of overflow)	803.1	804.4
Portage Lock	792.2	793.4
Section AD (D/S limit of overflow)	790.1	791.6
Baraboo Confluence	788.8	790.4
I-90-94 Bridge	781.8	782.9
Prairie du Sac Dam	774.0	774.0

For levee condition 4, the floodway included the first Lewiston and the Caledonia reservoirs as in levee condition 3. For the 100-year flood, overflow into the second Lewiston reservoir occurred between sections AT and AY. The depth and length of overflow were approximately 0.4 foot and 8,700 feet, respectively. During the SPF, the depth and length of overflow were approximately 1.4 feet and 10,700 feet, respectively.

There was no flow over the Portage levee for this levee condition during the 100-year flood. During the SPF, the overflow occurred between sections AD and AF. A splitting of the overflow between sections AD and AE occurred, with approximately one-third of the overflow in this reach backflowing up Duck Creek. The depth and length of the flow over the levees were approximately 1.5 feet and 2,200 feet, respectively.

The hydrographs for the second Lewiston reservoir are shown on Plate C-68. During the 100-year flood the volume of spillage was approximately 24,000 acre/feet and 6 days were required for routing. The reservoir stage peaked at approximately 792. At the SPF the spillage was approximately 200,000 acre/feet and approximately 10 days were required for the flow to pass through the reservoir. The peak stage in the reservoir was approximately 800.

Plate C-69 shows the SPF inflow-outflow hydrographs for the Fox River Swamp reservoir for levee condition 4. There was no overflow into the reservoir during the 100-year flood. During the SPF the spillage was approximately 250,000 acre/feet and approximately 10.5 days were required for routing. The reservoir peaked at a stage of approximately 785.

ASSUMED LEVEE CONDITION 5 (COMPLETE FAILURE OF THE PORTAGE LEVEE WITH THE CALEDONIA AND LEWISTON LEVEE HOLDING)

For this assumed levee condition, the water surface profile in reaches 1 and 3 was modeled using HEC-2. The water surface profile in reach 2 was modeled using "SPILL" calibrated to HEC-2 to account indirectly for variable

roughness factors across a given cross section. Interbasin flow to the Fox River begins at a Wisconsin River discharge of approximately 22,000 cfs having an exceedance probability of approximately 0.5. Levee overflow hydrographs away from the Wisconsin River were determined for the 100-year and standard project floods. These levee overflow hydrographs were routed through their respective storage areas to determine outflow hydrographs to the Fox River and Neenah Creek. The bivariate analysis discussed in detail in Appendix B was used to develop a frequency-discharge relationship below the Neenah Creek-Fox River confluence that accounts for Wisconsin River interbasin flow. Changes in flood discharges upstream of the Baraboo River and Duck Creek confluences with the Wisconsin River were developed using a bivariate statistical analysis discussed in detail in Appendix B. Interior drainage flooding due to surface runoff from interior drainage basins and seepage from the Wisconsin River would cause some flooding on the landward side of the Caledonia and Lewiston levees which may require interior drainage pumping stations. Refer to Plate C-38 for a flow schematic diagram of this assumed existing levee condition giving the numbers of plates containing pertinent information. Refer to Plates C-62 through C-68 for the water surface profiles and Plates C-39 through C-61 for the floodplain mapping. Water surface elevations at selected locations for this assumed existing levee condition are given in Table C-7.

TABLE C-7
WATER SURFACE ELEVATIONS AT SELECTED LOCATIONS
FOR ASSUMED LEVEE CONDITION 5

	Water Surface Elevations	
	100-year	SPF
Wisconsin Dells Gage	825.8	832.5
Section AY (U/S limit of overflow)	803.8	806.2
Portage Lock	795.0*	795.5*
Section AD (D/S limit of overflow)	788.9	789.5
Baraboo Confluence	787.8	788.3
I-90-94 Bridge	780.6	781.0
Prairie du Sac Dam	774.0	774.0

*Approximate due to specialized computations to account for submergence.

Overflow into the Lewiston reservoirs for this condition was very similar to the overflow for levee condition 2. Overflow into the Lewiston reservoirs occurred primarily in the reach between sections AS and AU. The depth and length of the overflow were approximately 1.0 foot and 2,300 feet, respectively, for the 100-year flood. For the SPF, the depth and length were approximately 2.0 feet and 2,700 feet, respectively.

The Caledonia reservoir received Wisconsin River overflows in the reach between sections AO and AS. For the 100-year flood, the depth of the overflow was approximately 0.3 foot and the total length of overflow was approximately 5,300 feet. For the SPF, the approximate depth and length were 1.0 foot and 11,000 feet, respectively.

Due to the special procedures used to compute overflow into the Fox River reservoir for this levee condition, the depth and length of levee overflow were not computed. The embankment used in the "SPILL" model in the Portage area was U.S. Highway 51. With the other levees remaining intact, the embankment became submerged at relatively low Wisconsin River discharges. Based on the results from levee condition 3, the depths of flow over U.S. Highway 51 for the 100-year flood were probably in the range from 2 to 4 feet. The length of overflow was probably approximately 9,000 feet. For the SPF, the depth was probably several feet greater than for the 100-year flood. The length of overflow was probably approximately that for the 100-year flood because of topographical conditions.

The hydrographs for the Lewiston reservoirs for levee condition 5 are shown on Plate C-90. For the 100-year flood, the spillage was approximately 25,000 acre/feet and 8 days were required for passage of the water through the reservoirs. The peak stage in the second reservoir was approximately 792. During the SPF, approximately 68,000 acre/feet of spillage occurred, and the routing required approximately 6 days. The peak stage in the second reservoir was approximately 801.

Plate C-91 shows the hydrograph for the Caledonia reservoir. Approximately 5,000 acre/feet of water spilled into the Caledonia reservoir during the 100-year flood and was routed out in approximately 3.5 days. The peak stage in the reservoir was 794.

During the SPF, approximately 68,000 acre/feet of spillage into Caledonia occurred. Attenuation in the reservoir was negligible and the overflow passed through the reservoir in approximately 6 days. The peak stage in the reservoir was approximately 795.

Plate C-92 shows the hydrographs for levee condition 5 for the Fox River Swamp reservoir. Spillage into the reservoir during the 100-year flood was approximately 87,000 acre/feet prior to submergence of the U.S. Highway 51 embankment. The peak stage in the reservoir was approximately 791. During the SPF, approximately 98,000 acre/feet of spillage occurred. The reservoir stage peaked at approximately 792. Due to the likelihood of water in the reservoir flowing back into the Wisconsin River as well as down the Fox River after submergence, the times required to route the spillages were not computed.

ASSUMED LEVEE CONDITION 6 (PORTAGE LEVEE HOLDS, LEWISTON LEVEE HOLDS, CALEDONIA FAILS COMPLETELY)

This levee condition was not studied in detail and engineering judgment was used to modify computer runs and backup data developed for the detailed study of levee conditions one through five to determine a reasonable representation of this mode of levee failure. The method of analysis is explained in the following paragraphs.

While analyzing levee condition 3 for the Wisconsin River at Portage Feasibility Study, several HEC-2 runs were made, including 10,000 cfs increments up to 100,000 cfs, the 1-percent and the SPF. On the Lewiston side, U.S. Highway 16 or the railroad embankment was used as a floodway limit instead of the levees. However, the increase in conveyance would not significantly affect the water surface profile. These profiles were plotted and compared to the top of the Lewiston levee. It was found that the 1-percent, 0.2 percent and SPF water surface profile elevations were

less than the elevation of the top of the Lewiston levees. The HEC-2 runs were, therefore, used to develop the required water surface profiles for this alternate. See Table C-8 for a listing of the 1-percent, 0.2 percent and SPF water surface profiles throughout the Portage area. See Plate C-93 for plotted water surface profiles.

For this levee condition there would not be any levee overflow into the Lewiston reservoir at least for discharges up to and including the SPF magnitude.

It is also estimated that there would be no spillage over the Portage levees into the Fox River Swamp for the 1-percent or the 0.2-percent chance flood. Approximate methods determined that there would be a peak escape flow of 9,000 cfs for the SPF event with a peak stage of 792.0 feet in the Fox River Swamp reservoir. The flooded outline for the 100-year flood would extend from the levees in the left overbank over to Interstate 94 in the upper reaches (upstream of T.H. 78) and over to the Baraboo River in the lower reaches. The flooded outline for the SPF event would approximately be the same as for the 100-year flood event except that the Fox River Swamp would also be flooded. The flooded outline for the Fox River Swamp would approximately be the same as for the levee condition 3 SPF event.

ASSUMED LEVEE CONDITION 7 (PORTAGE LEVEE HOLDS, CALEDONIA LEVEE HOLDS, LEWISTON LEVEE FAILS COMPLETELY)

This levee condition was not studied in detail and engineering judgment was used to modify computer runs and backup data developed for the detailed study of levee conditions one through five to determine a reasonable representation of this mode of levee failure. The method of analysis is explained in the following paragraphs.

This levee condition was analyzed by combining data developed for levee condition 2 and levee condition 3. For the 1-percent and the 0.2 percent flood events, water surface profiles were assumed and compared to levee condition 3, 1-percent, 0.2 percent and SPF profiles. This information

TABLE C-8

PROFILE FOR ASSUMED LEVEE CONDITION 6
PORTAGE LEVEE HOLDS, LEWISTON LEVEE HOLDS,
CALEDONIA LEVEE FAILS COMPLETELY

WATER SURFACE PROFILE - WISCONSIN RIVER AT PORTAGE

	100-Year	500-Year	SPF
AD (10)	790.25	791.90	793.03
AE 11	790.64	792.20	793.36
AF 12	790.96	792.60	793.65
AG 13	791.29	792.90	794.39
AH 14	791.72	793.30	794.95
AI 15.5	792.45	794.10	795.74
AJ 16	793.34	794.90	796.41
AK 16.1	793.51	795.10	796.59
AL 16.2	793.77	795.40	796.66
AM 16.5	794.60	796.20	797.36
AN 17.1	795.05	796.70	797.75
AO 17.2	795.08	796.70	-
AP 17.8	-	-	-
AQ 17.9	-	-	-
AR 21	796.10	797.70	798.64
AS 22	796.91	798.50	799.43
AT 23	798.31	799.70	800.93
AU 24	799.72	800.80	802.50
AV 27	801.61	802.70	804.41
AW 28	802.33	803.40	805.12
AX .1	802.64	803.70	805.48
AY 1	803.30	804.40	806.24
AZ 2	803.77	804.90	806.72
BA 3	804.59	805.70	807.68
BB 4	805.81	806.90	809.07
BC 5	806.57	807.70	809.89
BD 6	807.56	808.70	810.93
BE 7	809.54	810.60	813.05
BF 8	811.31	812.40	814.81
BG 9	812.44	813.50	815.96

was correlated with levee condition 3 Lewiston outflows. The Wisconsin River water surface profiles are based upon levee condition 2 geometry as Lewiston and Portage levees are assumed not to fail for this condition. For the SPF, a water surface profile on the Wisconsin River was first assumed. From this an elevation in the Lewiston reservoir was determined (equal to the average elevation of cross sections AT and AU). From the second Lewiston reservoir rating curve, a peak outflow was obtained. The Wisconsin River peak outflow was determined by assuming that the Lewiston reservoir will attenuate the peak by the ratio 1/1.3.

See Table C-9 for a tabulation of water surface elevations for the 1-percent, 0.2 percent and SPF events throughout the study area. See Plate C-94 for plotted water surface profiles.

The approximate methods described above determined that peak elevations in the Lewiston reservoir for the 1-percent, 0.2 percent and the SPF events to be 798.1, 799.5 and 802.2, respectively.

There would be no escape flow into the Caledonia reservoir for the 1-percent or the 0.2-percent event. There would be flow over the Caledonia levees for the SPF event with a peak stage in the Caledonia reservoir of 795.0.

There would be no escape flow into the Fox River Swamp at least for flood flows up to and including the SPF event.

The flooded outline for the 1-percent and the 0.2 percent flood events would remain within the levee boundaries on the Wisconsin River except at the Lewiston reservoir. The approximate flooded outline for the Lewiston reservoir for both events would be the same as the levee condition 3 SPF event.

The flooded outline for the SPF event would remain within the levee boundaries on the Wisconsin River except at the Lewiston and Caledonia reservoirs. The approximate flooded outline for the Lewiston and Caledonia reservoirs would be the same as the levee condition 2 SPF.

TABLE C-9
PROFILE FOR ASSUMED LEVEE CONDITION 7
COMPLETE FAILURE OF THE LEWISTON LEVEES, WITH OVER-TOPPING OF THE PORTAGE AND CALEDONIA LEVEES

WATER SURFACE PROFILE - WISCONSIN RIVER AT PORTAGE

	100-Yr.	500-Yr.	SPF
AD (10)	790.2	790.5	790.6
AE 11	790.4	790.7	790.8
AF 12	790.8	791.0	791.2
AG 13	792.3	792.6	792.7
AH 14	794.0	794.3	794.4
AI 15.5	795.4	795.6	795.8
AJ 16	-	-	-
AK 16	796.7	797.0	797.1
AL 16.2	797.1	797.6	797.9
AM 16.5	798.4	798.9	799.2
AN 17.1	799.0	799.4	799.8
AO 17.2	799.2	799.6	800.2
AP 17.8	-	-	-
AQ 17.9	-	-	-
AR 21	799.9	800.3	800.9
AS 22	800.4	800.8	801.4
AT 23	800.5	801.0	802.2
AU 24	800.6	801.4	803.3
AV 27	801.9	802.9	804.2
AW 28	802.5	803.3	804.7
AX .1	802.8	803.9	804.9
AY 1	803.5	804.7	805.5
AZ 2	804.1	805.1	806.5
BA 3	804.9	805.6	807.0
BB 4	805.8	806.4	807.8
BC 5	806.6	807.3	808.5
BD 6	807.6	808.5	810.0
BE 7	809.5	810.2	812.5
BF 8	811.2	812.0	814.5
BG 9	812.5	813.5	815.9

ASSUMED LEVEE CONDITION 8 (PORTAGE AND CALEDONIA LEVEES FAIL COMPLETELY, LEWISTON LEVEE HOLDS)

This levee condition was not studied in detail and engineering judgment was used to modify computer runs and backup data developed for the detailed study of levee conditions one through five to determine a reasonable representation of this mode of levee failure. The method of analysis is explained in the following paragraphs.

As explained in section "Assumed Levee Condition 6", there would be no flow over the Lewiston levee for the condition where the Caledonia levees fail and the Lewiston levee remains in place. As explained in section "Routing Levee Overflow or Breach Flow", several spill runs were made, based upon L.C. 3 geometry, to develop a set of approach Q versus spill Q curves. The approach Q is the discharge on the Wisconsin River upstream of the Fox River swamp and the spill Q is the basin escape flow to the Fox River swamp. These curves were used to estimate Fox River basin escape flow. Water surface profiles were then estimated based upon known discharge upstream of Fox River swamp and estimated downstream discharge. See Table C-10 for a tabulation of water surface elevation for the 1-percent, 0.2-percent and SPF events throughout the project area. See Plate C-95 for plotted water surface profiles.

The approximate methods described above determined peak elevations in the Fox River swamp for the 1-percent, 0.2 percent and the SPF events to be 786.0, 789.0 and 792.0.

There would be no escape flow into the Lewiston reservoir for this levee condition.

The flooded outline for the 1-percent, 0.2-percent and the SPF event would extend from the Lewiston levees in the left overbank over to Interstate 94 in the right overbank for the upper reaches (upstream of TH 78) as there would be no flow over the Lewiston levees. The flooded outline for the 1-percent, 0.2-percent and the SPF event for the lower reaches below T.H. 78 would be approximately the same as for the L.C. 3 SPF event.

TABLE C-10

PROFILE FOR ASSUMED LEVEE CONDITION 8
COMPLETE FAILURE OF THE PORTAGE AND CALEDONIA LEVEES,
WITH THE LEWISTON LEVEE HOLDING

WATER SURFACE PROFILE - WISCONSIN RIVER AT PORTAGE

		100 Year	500 Year	SPF
AD	(10)	789.5	790.0	791.0
AE	11	789.9	790.4	791.4
AF	12	790.3	790.8	791.8
AG	13	790.8	791.3	792.3
AH	14	791.4	791.9	792.9
AI	15.5	792.0	792.5	793.4
AJ	16	-	-	-
AK	16.1	793.7	795.1	796.6
AL	16.2	793.8	795.4	796.7
AM	16.5	794.6	796.2	797.4
AN	17.1	795.1	796.7	797.8
AO	17.2	795.1	796.7	800.2
AP	17.8	-	-	-
AQ	17.9	-	-	-
AR	21	796.1	797.7	798.6
AS	22	796.9	798.5	799.4
AT	23	798.3	799.7	800.9
AU	24	799.7	800.8	802.5
AV	27	801.6	802.7	804.4
AW	28	802.3	803.4	805.1
AX	.1	802.6	803.7	805.5
AY	1	803.3	804.4	806.2
AZ	2	803.8	804.9	806.7
BA	3	804.6	805.7	807.7
BB	4	805.8	806.9	809.1
BC	5	806.6	807.7	809.9
BD	6	807.6	808.7	810.9
BE	7	809.5	810.6	813.1
BF	8	811.2	812.4	814.8
BG	9	812.5	813.5	815.9

ASSUMED LEVEE CONDITION 9 (PORTAGE AND LEWISTON LEVEES FAIL COMPLETELY, CALEDONIA LEVEE HOLDS)

This levee condition was not studied in detail and engineering judgment was used to modify computer runs and backup data developed for the detailed study of levee conditions one through five to determine a reasonable representation of this mode of levee failure. The method of analysis is explained in the following paragraphs.

This analysis was carried out in two parts: 1. for the reach of the Wisconsin River upstream of T.H. 78 and 2. for the reach of the Wisconsin River downstream of T.H. 78.

For the reach upstream of T.H. 78.

This section was analyzed by combining data developed for levee condition 2 and levee condition 3. For the 1-percent and the 0.2-percent flood events, water surface profiles were assumed and compared to L.C. 3 1-percent, 0.2-percent and SPF profiles. This information was correlated with L.C. 3 Lewiston outflows. The Wisconsin River water surface profiles are based upon L.C. 2 geometry as the Lewiston levees are assumed not to fail for this condition. For the SPF, a water surface profile on the Wisconsin River was first assumed. From this an elevation in the Lewiston Reservoir was determined (equal to the average elevation at cross section AT and AO). From the second Lewiston Reservoir rating curve, a peak outflow was obtained. The Wisconsin River peak overflow was determined by assuming that the Lewiston Reservoir will attenuate the peak by the rate 1/1.3.

By subtracting the Lewiston Reservoir escape flow from the Wisconsin River approach flow, the discharge remaining in the Wisconsin River downstream of the Lewiston levee area is determined. This flow rate was the approach discharge for the reach downstream of T.H. 78.

For the reach downstream of T.H. 78.

As explained in section "Routing Levee Overflows and Reach Flow", several spill runs were made, based upon L.C. 5 geometry, to develop a set of approach Q versus spill Q curves. The approach Q is the discharge on the Wisconsin River upstream of the Fox River swamp and the spill Q is the basin escape

flow to the Fox River swamp. These curves were used to estimate Fox River basin escape flow. Water surface profiles were then estimated based upon known discharge upstream of the Lewiston Reservoir and estimated downstream discharge. See Table C-11 for a tabulation of water surface elevations for the 1-percent, 0.2-percent and SPF events throughout the project area. See Plate C-96 for plotted water surface profile.

The approximate methods described above determined that the peak elevation in the Lewiston reservoir for the 1-percent, 0.2-percent and the SPF events to be 792.0, 797.1 and 801.0.

The approximate methods described above determined that there would be no basin escape flow over the Caledonia levees for the 1-percent and the 0.2-percent flood events. There would be flow into the Caledonia reservoir for the SPF event with a peak stage of 795.0.

The approximate methods described above determined that the peak elevation in the Fox River Swamp Reservoir for the 1-percent, 0.2-percent and the SPF events to be 789.0, 789.2 and 789.3.

The flooded outline for the 1-percent and the 0.2-percent flood events would remain within the levee boundaries except for the Lewiston Reservoir and the Fox River Swamp area. The approximate flooded outline for these two areas for the 1-percent event would be the same as the L.C. 3 1-percent event. The flooded outline for the 0.2-percent event would approximately be the same as the L.C. 3 SPF event for the Lewiston Reservoir area and would approximately be the same as the L.C. 3 1-percent event for the Fox River swamp area.

The flooded outline for the SPF event would approximately be the same as the L.C. 2 SPF event for the Lewiston Reservoir and the Caledonia Reservoir areas. The flooded outline for the Fox River swamp area would approximately be the same as the L.C. 3 1-percent flood event.

TABLE C-11

PROFILE FOR ASSUMED LEVEE CONDITION 9
PORTAGE AND LEWISTON LEVEES FAIL COMPLETELY, CALEDONIA LEVEES HOLD

WATER SURFACE PROFILE - WISCONSIN RIVER AT PORTAGE

	100 Year	500 Year	SPF
AD (10)	788.0	788.1	788.3
AE 11	790.0	790.1	790.3
AF 12	791.0	791.1	791.3
AG 13	791.4	791.5	791.7
AH 14	793.0	793.1	793.3
AI 15.5	794.3	794.4	794.6
AJ 16	-	-	-
AK 16.1	795.9	796.0	796.2
AL 16.2	797.1	797.6	797.9
AM 16.5	798.4	798.9	799.2
AN 17.1	799.0	799.4	799.8
AO 17.2	799.2	799.6	800.2
AP 17.8	-	-	-
AQ 17.9	-	-	-
AR 21	799.9	800.3	800.9
AS 22	800.4	800.8	801.4
AT 23	800.5	801.0	802.2
AU 24	800.6	801.4	803.3
AV 27	801.8	802.9	804.2
AW 28	802.5	803.3	804.7
AX .1	802.8	803.9	804.9
AY 1	803.5	804.7	805.5
AZ 2	804.1	805.1	806.5
BA 3	804.9	805.6	807.0
BB 4	805.8	806.4	807.8
BC 5	806.6	807.3	808.5
BD 6	807.6	808.5	810.0
BE 7	809.5	810.2	812.5
BF 8	811.2	812.0	814.5
BG 9	812.5	813.5	815.9

COMPARISON OF THE RESULTS OF THE ASSUMED LEVEE CONDITIONS ANALYSES

Approximate values of inundated area, peak stage and greatest depth for the lateral reservoirs are shown in Table C-12 for levee conditions one through five. The inundated areas were based on the delineations shown on Plates C-7 through C-29 and C-39 through C-61. The greatest depth in the reservoir was computed by subtracting the lowest elevation in the reservoir from the peak stage determined from routing. For the second Lewiston and Fox River swamp reservoirs, the greatest depth in the reservoir occurred near the outlet from the reservoir. In the Caledonia reservoir, the greatest depth occurred in the low areas west of Wisconsin S.T.H. 78.

Comparison of the results from the hydraulic analyses for levee conditions one through five can be facilitated through the use of Table C-12 and the water surface profiles shown on Plates C-30 through C-36 and C-62 through C-68.

TABLE C-12

APPROXIMATE DEPTHS, PEAK STAGES, AND INUNDATED AREAS IN THE LATERAL RESERVOIRS FOR LEVEE CONDITIONS 2 THROUGH 5

	L.C. 2		L.C. 3		L.C. 4		L.C. 5	
	100 Yr	SPF	100 YR	SPF	100 YR	SPF	100 YR	SPF
First Lewiston Res.								
Inundated Area (ac.)	960	1420	*	*	*	*	960	1420
Peak Stage (ft.)	798	801[o]	*	*	*	*	798	801[o]
Greatest Depth (ft.)	6	0	*	*	*	*	6	0
Second Lewiston Res.								
Inundated Area	2550	8000	2550	7500	2500	7500	2550	8000
Peak Stage	792	801[o]	792	800	792	800	792	801[o]
Greatest Depth	12	21	12	20	12	20	12	21
Caledonia Res.								
Inundated Area	960	3300	*	*	*	*	960	3300
Peak Stage	794	795	*	*	*	*	794	795
Greatest Depth	9	10	*	*	*	*	9	10
Fox R. Swamp Res.								
Inundated Area	90	90	2550	2550	0	2200	2550	2550
Peak Stage	778	779	789	792	-	783	791	792
Greatest Depth	0	1	10	13	0	4	12	13

[o] A composite of the first and second Lewistons was used for this condition.

* For these conditions, the reservoirs were in the Wisconsin River floodway.

FLOOD INSURANCE STUDIES

GENERAL

Two flood insurance studies have recently been completed for the study area, the purpose of which was to investigate the existence and severity of flood hazards for the incorporated area of the City of Portage, Columbia County, Wisconsin, and the unincorporated areas of Columbia County, Wisconsin.

For the flood insurance studies, water surface profiles were computed for the 10-, 50-, 100- and 500-year floods on the Wisconsin River using procedures explained in detail above for assumed levee condition 3 - (no levees).

The peak discharges used for the 10-, 50-, 100- and 500-year floods in the computations were those at Wisconsin Dells as developed by the U.S. Geological Survey. The spill model was used to compute the water surface profiles for the reach between sections AD and BC; and HEC-2 was used for the reaches from A to AD and BC to CK.

Water surface computations are based on the levee condition assumption that all the levees along the Wisconsin River in the vicinity of Portage, Wisconsin, will fail. Overflow from the Wisconsin River into Neenah Slough would occur for the 50-, 100- and 500-year floods, but not for the 10-year. Overflow into the Fox River near Portage would occur for the 10-, 50-, 100- and 500-year floods.

For the 500-year flood, the embankment used as a lateral weir on the Portage side would become submerged and the specialized procedures used in this reach for the SPF analysis, as explained in section "Routing Levee Overflow and Breach Flows", were used. The weir coefficient KC was lowered to 0.8 in the SPILL model to account for the submergence that would occur during the 500-year peak.

The 500-year flood was routed only until the time the Wisconsin River stage peaked at section AE. After that time, the Fox River reservoir could have overflow both into the Fox River and back into the Wisconsin River. Important features of the two Flood Insurance Studies are discussed below.

FLOOD INSURANCE STUDY - COLUMBIA COUNTY, UNINCORPORATED AREAS, WISCONSIN

This Flood Insurance Study covers the unincorporated areas of Columbia County, including those held by the U.S. Fish and Wildlife Service, the Wisconsin Department of Natural Resources, the State Department of Transportation, and the University of Wisconsin.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction until June 1982.

Approximate methods of analysis were used to study those areas having low development potential and/or minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by the Federal Insurance Administration and the community.

The following streams were studied in detail: the Wisconsin River for the entire length within the county for interbasin flow conditions; the Fox River from the Marquette County line to about 4.58 miles upstream of the northerly corporate limits of Pardeeville, excluding the City of Portage and Village of Pardeeville; the Crawfish River about 7.41 miles from State Highway 73 to about 1.87 miles upstream of Hall Road; North Branch Crawfish River, including Lazy Lake, from County Traunk Highway DG to the northern corporate limits of the Village of Fall River; Duck Creek from its mouth to the Village of Wyocena corporate limits; and the Baraboo River from its mouth upstream to the I-94 bridge.

The approximate study streams include: The Crawfish River from 1.87 miles upstream of Hall Road to Highway C; and North Branch Crawfish River upstream of County Trunk Highway DG. Other flooding sources studied by approximate methods include:

Corning L. Tributary to the Wisconsin River	Rocky Run
Big Slouth	Hinkson Creek
Neenah Creek	Rowan Creek
French Creek	Spring Creek
Dates Mill Pond Tributary	Robbins Creek
Sand Spring Creek	Powers Creek
North Branch Duck Creek	Rowley Creek
Middle Branch Duck Creek	Lodi Marsh Creek
Jennings Creek	Crystal Lake
Beaver Creek	Spring Creek

HYDRAULIC ANALYSES

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the flood elevations of selected recurrence intervals along each flooding source studied in detail.

For interbasin flow conditions, the peak discharge values were developed routing interbasin flow from the Wisconsin River as discussed in sections "Wisconsin River Flood Routing" and "Routing Levee Overflow or Levee Failure Flow." The resulting controlling peak discharges used are shown in Table C-13.

TABLE C-13

SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ. MILES)	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
WISCONSIN RIVER - (Interbasin Flow)					
At Columbia/Sauk-Juneau/Adams County Line	7,760	54,000	76,000	85,000	105,000
At Portage gage	7,830	56,000	76,200	84,500	94,200
Downstream of Baraboo River confluence	8,480	54,300	65,500	68,800	80,100
Sauk-Columbia County Line	8,950	54,300	65,500	68,800	80,100
FOX RIVER - (Interbasin Flow)					
At Columbia-Marquette County Line	369.9	2,924	7,357	12,753	21,427
X-Sec. G	93.4	450	4,885	8,780	12,360
X-Sec. AF	68.0	450	5,970	10,400	13,790
Park Lake Dam*	53.8	1,250*	1,580*	1,700*	2,000*
BARABOO RIVER					
-No Interbasin Flow					
At Mouth	650	6,000	8,200	9,000	10,600
Interbasin Flow**	13	N/A	N/A	N/A	N/A
NEENAH CREEK - (Interbasin Flow)					
At Mouth	139	3,470	5,835	7,730	15,175
DUCK CREEK					
At Mouth	93.4	1,900	2,100	2,400	3,050
At downstream corporate limits of Wyocena	75.3	2,350	3,650	4,200	6,000
CRAWFISH RIVER					
At dam in Columbus	171.7	1,250	1,710	1,890	2,260
Downstream of confluence of Robbins Creek	150.3	1,130	1,540	1,690	2,030
Downstream of confluence of North Branch Crawfish River	134.5	1,030	1,400	1,550	1,850
NORTH BRANCH CRAWFISH RIVER					
Upstream of Lazy Lake	75.2	640	870	960	1,150

No Interbasin Flow Controls.
* Part of Wisconsin River Overflow and Therefore Values not Applicable.

Cross section data and structure data necessary for this analysis were developed by field survey. Photos of the overbanks and the channel at most cross section locations were obtained in the field. The procedures used for calculating head losses through bridges and other structures causing constrictions to flow allowed the identification of significant backwater producing structures. Stream cross sections obtained from the Wisconsin Department of Natural Resources were used on the Fox River in Marquette County which borders Columbia County on the north. Incorporating these cross sections into the hydraulic model afforded the starting of the hydraulic model for the county just upstream of the Buffalo Lake Dam which is the downstream hydraulic control point for the river. Cross sections on the studied streams within Columbia County were determined by field measurement.

Overbank roughness factors (Manning's "n") for the Wisconsin, Fox, Baraboo and Crawford Rivers and Neenan and Duck Creeks and tributaries were estimated from photos taken at cross section locations and field observations. Channel roughness factors were estimated by comparison with table values and the step-by-step procedure for channel "n" values in Chow's text on open channel hydraulics (reference 2). Table C-14 summarizes the range of "n" values for selected streams.

TABLE C-14
MANNING'S "n" ROUGHNESS COEFFICIENTS

Stream	Channel "n" Range	Overbank "n" Range
Wisconsin River	.030 - .040	.065 - .10
Fox River	.020 - .080	.040 - .12
Baraboo River	.035 - .040	.065 - .08
Crawfish River and tributaries	.025 - .088	.025 - .12
Duck Creek	.035 - .045	.080 - .12
Neenah Creek	.030 - .040	.055 - .07

Water surface profiles downstream of the Prairie du Sac Dam on the Wisconsin River were computed by the USGS using the Dane County Flood Insurance Study hydraulic model. Starting water surfaces upstream of the Prairie du Sac Dam on the Wisconsin River were computed based on the dam's spillway capacities. Starting water surface elevations on the Fox River were determined at the Buffalo Lake and Park Lake Dams by developing elevation-discharge rating curves for the dam spillways. Similarly, starting water surface elevations were determined from dam rating curves for the Crawfish River at dams in Columbus and Fall River. On the Baraboo River, Duck Creek and Neenah Creek, the starting water surfaces were based on normal high water of confluencing streams. At these hydraulic control points, it was possible to determine stage as a single valued function of discharge. Water surface elevations were computed using the COE step-backwater computer program (reference 5) for all streams with no interbasin flow conditions. For interbasin flow conditions, the SPILL model (reference 1) program was used. This model coupled with Puls outflow routings affect the water surface profiles on the Wisconsin, Baraboo and Fox Rivers as well as Neenah Creek. For the Wisconsin River reach downstream of Prairie du Sac Dam, the water surface profiles were computed using USGS's water surface profile program. Thus, the usage of the results from SPILL, Puls routings, and HEC-2 were combined as necessary to reflect the controlling water surface for these streams.

FLOOD INSURANCE STUDY - CITY OF PORTAGE, WISCONSIN

This flood insurance study covers the incorporated area of the city of Portage, Columbia County, Wisconsin.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or porposed construction for the next 5 years, through June 1986.

Approximate methods of analysis were used to study those areas having a low development potential or minimal flood hazard as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by FEMA and the city of Portage.

The Wisconsin and Fox Rivers were studied in detail within the corporate limits. The effects of with and without interbasin flow were studied from the Wisconsin to the Fox Rivers. The interbasin flow concept refers to the outflow of the Wisconsin River into the Fox River upstream (by Slough-Neenah Creek area) and downstream (via Duck Creek) of the city of Portage, respectively. Interbasin flow includes flow into the Baraboo River system westerly of the city of Portage. All existing levees on both sides of the Wisconsin River are assumed to fail for this condition.

HYDRAULIC ANALYSES

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

Table C-15 summarizes the specific discharges at selected locations, as derived from the interbasin flow condition whereby all levees were assumed to fail, and with the levees assumed to hold condition (no interbasin flow).

TABLE C-15
SUMMARY OF DISCHARGES

Flooding Source and Location	Drainage Area (Sq. Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Wisconsin River at Portage gage					
-No Interbasin Flow	7,830	54,000	76,000	85,000	105,000
-Interbasin Flow	7,830	54,000	76,000	84,500	94,200
Fox River Interbasin Flow					
S.T.H. 33 Bridge	73.4	450	5,970	10,400	13,790

Overbank roughness factors (Manning's "n") for the Wisconsin and Fox Rivers were estimated from photographs taken at cross section locations and field observations. Channel roughness factors were estimated by comparison with table values and the step-by-step procedure for channel "n" values in Chow's text on open channel hydraulics (reference 2). These ranged from 0.030 to .040 for channel and 0.065 to 0.10 for overbanks on the Wisconsin River. For the Fox River, these values varied from 0.02 to 0.080 in the channel and 0.040 to 0.12 for overbanks.

Starting water surfaces for the Wisconsin River were computed using rating curves for the Prairie du Sac Dam. For the Fox River, starting water surface elevations were determined using rating curves at the Buffalo Lake Dam.

Water surface elevations were computed using the Corps of Engineers HEC-2 step backwater computer program (reference 5) for no interbasin flow conditions. For interbasin flow conditions, the "SPILL" model (reference 1) program was used; this model coupled with Puls overflow routings affect the water surface profiles on the Wisconsin and Fox Rivers. For the interbasin flow area, water surface elevations were computed using the HEC-2 program and the SPILL model, but no profile was drawn for this area. The water surface profiles for the Wisconsin River were drawn based upon the total levee failure condition.

The Fox River floodplain provides large amounts of storage in the overbanks, thus the determination of the flow areas required to pass the 100-year flood peak discharge with no significant increase in water-surface elevation resulted in a hydraulic floodway with encroachment limits well within the limits of the floodplain. Although the area outside the limits of the floodway would not be required to pass the 100-year flood peak discharge, significant development in the area between the floodway and the floodplain limits would result in a reduction in available storage volume, thus increasing the peak discharge. This storage area, with and without

interbasin flow, needs to remain open. Similarly, interbasin flow results in the usage of storage areas along the Wisconsin River.

Flood profiles were drawn showing the computed water surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

SELECTED PLAN

GENERAL

Various alternatives described in the main report and the Plan Formulation Appendix A were developed and compared in order to select the most feasible plan. For the selected plan, the existing Portage levee from Portage canal lock downstream to Ontario Street would be strengthened, widened and extended. Downstream of Ontario Street the existing Portage levee would be realigned. The new alignment would follow closely the present alignment of TH 51. Two additional levees are needed in the Summit Street and Pauquette Park areas of Portage. The first levee would provide for raising Summit Street from River Street to Carroll Street. A second levee would be needed from Conant Street to the STH 33 bridge then from the bridge downstream to almost Dunn Street. (See Plate C-97.) The 0.2-percent chance flood would require levee heights of approximately 10 feet. No new work is to be done on the existing Lewiston or Caledonia levees.

DEGREE OF PROTECTION

The proposed levee on the Wisconsin River would provide protection against flood events up to the 0.2-percent flood in the floodprone areas of the City of Portage. A levee designed to provide protection against the standard project flood event was considered but the hydraulic analysis showed that flood damages would still occur in the Ward 1 area of Portage for flood events with exceedence frequencies greater than 0.2-percent due to Lewiston levee overflow/breach flow or to coincident Fox River flow. (See method of analysis section for complete discussion.)

FEATURES OF THE RECOMMENDED PLAN

The specific features of the recommended plan is discussed in the main report.

METHOD OF ANALYSIS AND IMPACT EVALUATION

General

For the selected plan, four possible failure mode combinations of the existing Lewiston and Caledonia levees were identified and analyzed with respect to their impact on flood flows, stage and frequency. The failure modes were not studied in detail. Engineering judgment was used to modify computer runs and back-up data developed for the detailed analysis of levee conditions one through five to determine a reasonable representation of the four possible levee failure modes. For each failure mode the following was determined: (1) Discharge-frequency curves at cross section AD (see Appendix B for discussion), (2) Discharge-frequency curves downstream of the mouth of the Baraboo River (see Appendix B for discussion), (3) Water surface profiles for the 1-percent, 0.2-percent exceedence frequencies and the SPF events were developed throughout the study reach, (4) Approximate peak stages in the lateral reservoirs (Lewiston Reservoir, Caledonia Reservoir and the Fox River Swamp Reservoir) for flood events with exceedence frequencies of 10-percent (5-percent for condition A-C), 2-percent, 1-percent, 0.2-percent and the SPF event.

The method used for determining the elevations in the Lewiston and the Caledonia Reservoirs has already been discussed under Existing Conditions. The following additional procedures were used to determine elevations in the Fox River Swamp Reservoir.

For a particular flood event on the Wisconsin River, water could enter the Fox River Reservoir from either upstream, due to coincident Fox River flow, or downstream, due to Wisconsin River flow over/through the Lewiston Levee going down Neenah Creek and backing up the Fox River (for this alternate there would be no direct flow into the Fox River Reservoir from the Wisconsin River over or through the Portage Levees).

The water surface elevation in the reservoir for the 10-percent, 2-percent, 1-percent, 0.2-percent flood events and the SPF on the Wisconsin River were first determined based upon coincident flow on the Fox River.

Water surface elevations in the reservoir were then determined by routing the corresponding outflow hydrograph from the composite Lewiston reservoir through the Neenah Creek, Fox River storage system by the Modified Puls method. The higher of these two elevations would be the elevation obtained in the Fox River Swamp for a particular flood event on the Wisconsin River.

The assumed levee failure conditions will be identified as follows.

Alternate A-A - Complete failure of the Caledonia Levee with Lewiston Levee holding.

Alternate A-B - Complete failure of the Lewiston and Caledonia Levees.

Alternate A-C - Overtopping of the Lewiston and Caled[illegible]

Alternate A-D - Complete failure of the Lewiston Levee [illegible] Caledonia Levee holding.

<u>Alternate A-A.</u> Complete failure of the Caledonia Levee with the Lewiston Levee holding.

The method of analysis for this levee condition was the same as that discussed in the section under "Existing Conditions - Portage Levee Holds, Lewiston Levee holds, Caledonia fails". The one difference is that, for this case, the Portage levees would not be overtopped. See Table C-16 for peak stages in the lateral reservoirs for this alternate. See Table C-17 for tabulation of Wisconsin River water surface profile elevations for the 1-percent, 0.2-percent and SPF events throughout the study reach. See Plate C-98 for elevation-frequency curves showing peak elevations in the lateral reservoirs for Alternate A-A.

The flooded outline would approximately be the same for the 1-percent, 0.2-percent and SPF events. The outline would extend from the levees in the left overbank over to the Interstate 94 roadway in the upper reaches (upstream of TH 78) and over to the Baraboo River in the lower reaches.

Elevations in the Fox River Swamp area were determined as noted in the "General" section, "Method of Analysis and Impact Evaluation."

TABLE C-16

ALTERNATE A - RAISE AND WIDEN THE PORTAGE LEVEE

Approximate Peak Stages in the Lateral Reservoirs
for each of the Alternate Conditions Footnoted

Lateral Reservoir Location	Alternate Condition A-A[1] 10%	2%	1%	0.2%	SPF	Alternate Condition A-B[2] 10%	2%	1%	0.2%	SPF
First Lewiston Reservoir						(Cross section AT)				
Peak Elevation	*	*	*	*	*	[illegible]	[illegible]	798.2	798.5	799.3
Second Lewiston Reservoir										
Peak Elevation	*	*	*	*	*	*	789.7	792.0	795.3	800.0
Caledonia Reservoir	(Cross section AM)					(Cross section AM)				
Peak Elevation	[illegible]	[illegible]	794.6	796.2	797.4	[illegible]	[illegible]	794.4	795.1	795.4
Fox River Swamp Reservoir	**	**	**	**	**	**	**	**	**	X
Peak Elevation	782.6	783.5	783.8	784.2	785.0	782.6	783.5	783.8	784.2	785.4

Lateral Reservoir Location	Alternate Condition A-C[3] 5%	2%	1%	0.2%	SPF	Alternate Condition A-D[4] 10%	2%	1%	0.2%	SPF
First Lewiston Reservoir					■	(Cross section AT)				
Peak Elevation	792.3	797.2	798.0	798.4	801.1	797.0	[illegible]	800.5	801.0	802.2
Second Lewiston Reservoir					■					
Peak Elevation	*	783.3	792.0	797.1	801.0	[illegible]	[illegible]	798.1	799.5	802.2
Caledonia Reservoir										
Peak Elevation	*	*	794.0	794.5	795.0	*	*	*	*	795.0
Fox River Swamp Reservoir	**	**	**	**	X	**	**	**	**	X
Peak Elevation	783.0	783.5	783.8	784.2	787.0	782.6	783.5	783.8	784.2	788.0

Footnotes:
Alternate Conditions:

1. A-A COMPLETE FAILURE OF THE CALEDONIA LEVEE WITH LEWISTON HOLDING.
2. A-B COMPLETE FAILURE OF THE LEWISTON AND CALEDONIA LEVEES.
3. A-C OVERTOPPING OF THE LEWISTON AND CALEDONIA LEVEES.
4. A-D COMPLETE FAILURE OF THE LEWISTON LEVEE, CALEDONIA LEVEE HOLDS.

* No overflow for this exceedance frequency flood event.
** Elevation for Fox River Swamp Reservoir determined by coincident Fox River discharge.
X Elevation determined by backwater from Neenah Creek - Lewiston overflow.
■ A composite of the First and Second Lewiston Reservoir was used for this condition.
( ) The reservoir is in the Wisconsin River floodway.

TABLE C-17

PROFILE FOR ALTERNATE A-A
COMPLETE FAILURE OF THE CALEDONIA LEVEE
WITH THE LEWISTON LEVEE HOLDING

WATER SURFACE PROFILE - WISCONSIN RIVER AT PORTAGE

	100-Year	500-Year	SPF
AD (10)	790.25	791.90	794.03
AE 11	790.64	792.20	794.36
AF 12	790.96	792.60	794.65
AG 13	791.29	792.90	794.89
AH 14	791.72	793.30	795.20
AI 15.5	792.45	794.10	795.74
AJ 16	793.34	794.90	796.41
AK 16.1	793.51	795.10	796.59
AL 16.2	793.77	795.40	796.66
AM 16.5	794.60	796.20	797.36
AN 17.1	795.05	796.70	797.75
AO 17.2	795.08	796.70	0.00
AP 17.8	0.00	0.00	0.00
AQ 17.9	0.00	0.00	0.00
AR 21	796.10	797.70	798.64
AS 22	796.91	798.50	799.43
AT 23	798.31	799.70	800.93
AU 24	799.72	800.80	802.50
AV 27	801.61	802.70	804.41
AW 28	802.33	803.40	805.12
AX .1	802.64	803.70	805.48
AY 1	803.30	804.40	806.24
AZ 2	803.77	804.90	806.72
BA 3	804.59	805.70	807.68
BB 4	805.81	806.90	809.07
BC 5	806.57	807.70	809.89
BD 6	807.56	808.70	810.93
BE 7	809.54	810.60	813.05
BF 8	811.51	812.40	814.81
BG 9	812.44	813.50	815.96

Alternate A-B. Complete failure of the Lewiston and Caledonia Levees.

The analysis for this alternate is similar to that discussed in the section titled "Existing Conditions-Assumed Levee Condition 4 (Complete failure of the Caledonia and Lewiston levees with Portage holding)." Plate 89, developed for Levee Condition 4 for the Wisconsin River at Portage Feasibility Study shows essentially no overflow into the Fox River Swamp Reservoir for the 1-percent flood event and very little flow over the Portage levees for the SPF event. For the 1-percent event, therefore, water surface elevations, peak reservoir elevations, etc., both for this levee condition and Levee Condition 4, are the same. Engineering judgment was used to modify Levee Condition 4 results to obtain what is felt are reasonable approximations of other flood events for this alternate. See Table C-16 for peak stages in the lateral reservoirs and Table C-18 for tabulation of Wisconsin River water surface elevations for the 1-percent, 0.2-percent and SPF events throughout the study reach. See Plate C-99 for elevation-frequency curves showing peak elevations in the lateral reservoirs for Alternate A-B.

The flooded outline for the 100-year and the Standard Project Flood event would approximately be the same as in Levee Condition 4 except for the Fox River Swamp area. Elevations in the Fox River Swamp area were determined as stated in the "General" section, "Method of Analysis and Impact Evaluation".

Alternate A-C. Overtopping of the Lewiston and Caledonia Levees.

The analysis for this alternate is similar to that discussed in the section titled "Existing Conditions - Assumed Existing Levee Condition 2 (Levees Overtopped but not Breached)." Plate 85, developed for Levee Condition 2 for the Wisconsin River at Portage Feasibility Study shows essentially no overflow into the Fox River Swamp Reservoir for the 1-percent flood event or the SPF event. Water surface profiles, peak reservoir elevations, etc. for this alternate condition for a particular flood event were assumed to be the same as the corresponding Levee Condition 2 situation as flow conditions for both cases would be virtually the same. See Table C-16 for peak stages in the lateral reservoirs and

TABLE C-18
PROFILE F^R ALTERNATE A-B
COMPLETE FAILURE OF THE LEWISTON AND CALEDONIA LEVEES

WATER SURFACE PROFILE - WISCONSIN RIVER AT PORTAGE

	100-Year	500-Year	SPF
AD (10)	789.80	791.00	791.20
AE 11	790.14	791.30	791.50
AF 12	790.32	791.50	791.70
AG 13	790.77	791.80	792.10
AH 14	791.31	792.20	792.60
AI 15.5	792.18	793.00	793.40
AJ 16	0.00	793.80	0.00
AK 16.1	793.69	794.00	794.70
AL 16.2	793.73	794.30	794.70
AM 16.5	794.41	795.10	795.40
AN 17.1	0.00	795.50	0.00
AO 17.2	0.00	795.60	796.00
AP 17.8	0.00	0.00	796.10
AQ 17.9	0.00	0.00	0.00
AR 21	796.16	797.60	797.00
AS 22	796.73	797.40	797.80
AT 23	798.20	798.50	799.30
AU 24	799.49	799.70	800.60
AV 27	801.39	802.20	802.50
AW 28	802.07	802.70	803.20
AX .1	802.38	803.00	803.60
AY 1	803.12	803.70	804.40
AZ 2	803.76	804.30	805.10
BA 3	804.78	805.30	806.20
BB 4	805.87	806.30	807.40
BC 5	806.58	807.20	808.20
BD 6	807.50	808.40	809.80
BE 7	809.50	810.60	812.40
BF 8	811.30	812.60	814.40
BG 9	812.40	813.80	815.70

TABLE C-19

PROFILE FOR ALTERNATE A-C

OVERTOPPING OF THE LEWISTON AND CALEDONIA LEVEES

WATER SURFACE PROFILE - WISCONSIN RIVER AT PORTAGE

	100-Year	500-Year	SPF
AD (10)	790.20	790.50	790.60
AE 11	790.40	790.67	790.77
AF 12	790.80	791.09	791.19
AG 13	792.30	792.57	792.69
AH 14	794.00	794.30	794.44
AI 15.5	795.40	795.69	795.83
AJ 16	0.00	0.00	0.00
AK 16.1	796.70	796.99	797.14
AL 16.2	797.10	797.59	797.94
AM 16.5	798.40	798.88	799.23
AN 17.1	799.00	799.44	799.80
AO 17.2	799.20	799.64	800.20
AP 17.8	799.80	0.00	0.00
AQ 17.9	799.90	0.00	0.00
AR 21	799.90	800.34	800.88
AS 22	800.40	800.82	801.36
AT 23	801.00	801.49	802.15
AU 24	801.70	802.38	803.31
AV 27	803.10	803.90	805.22
AW 28	803.50	804.31	805.71
AX .1	803.60	804.44	805.87
AY 1	803.80	804.70	806.15
AZ 2	804.20	805.09	806.53
BA 3	804.90	805.64	807.04
BB 4	805.80	806.50	807.76
BC 5	806.60	807.30	808.53
BD 6	807.60	808.50	810.01
BE 7	809.50	810.20	812.50
BF 8	811.30	812.00	814.50
BG 9	812.50	813.20	815.89

Table C-19 for tabulation of Wisconsin River water surface elevations for the 1-percent, 0.2-percent and SPF events throughout the study reach. See Plate C-100 for elevation frequency curves showing peak elevations in the lateral reservoirs for Alternate A-C.

The flooded outline for this alternate would be the same as for Existing Conditions-Levee Condition 2 except for the Fox River Swamp area. See Table C-16 for peak stages in the Fox River Swamp area. Elevations in the Fox River Swamp area were determined as stated in the "General" section, "Method of Analysis and Impact Evaluation."

Alternate A-D. Complete failure of the Lewiston Levee, Caledonia Levee Hold.

This mode of levee failure was analyzed as a modification of Existing Conditions-Levee Condition 2. For the 1-percent and 0.2-percent flood events, water surface profiles were assumed and compared to Existing Conditions-Levee Condition 3, 1-percent, 0.2-percent and SPF profiles. This information was correlated with Existing Conditions-Levee Condition 3 Lewiston outflows. The Wisconsin River water surface profiles are based upon Existing Condition-Levee Condition 2 geometry. For the SPF, a water surface profile on the Wisconsin River was first assumed. From this an elevation in the Lewiston Reservoir was determined (equal to the average elevation at cross sections AT and AU). From the second Lewiston Reservoir rating curve, a peak outflow was obtained. The Wisconsin River peak outflow was determined by assuming that the Lewiston Reservoir will attenuate the peak by the ratio 1/1.3. See Table C-20 for tabulation of Wisconsin River water surface elevations for the 1-percent, 0.2-percent, and SPF events throughout the study reach. See Table C-16 for peak stages in the lateral reservoirs. See Plate C-101 for elevation frequency curves showing peak elevations in the lateral reservoirs.

The flooded outline for the 1-percent and the 0.2 percent flood events would remain within the levee boundaries on the Wisconsin River except at the Lewiston reservoir. The approximate flooded outline for the Lewiston reservoir for both events would be the same as the levee condition 5 SPF event.

The flooded outline for the SPF event would remain within the levee boundaries on the Wisconsin River except at the Lewiston and Caledonia reservoirs. The approximate flooded outline for the Lewiston and Caledonia reservoirs would be the same as the levee condition 2 SPF.

The elevations in the Fox River swamp area were determined as stated in the "General" section, "Method of Analysis and Impact Evaluation."

DESIGN WATER SURFACE PROFILE

For Alternate A, the water surface profile corresponding to a 0.2-percent selected level of protection was developed. Because there are four possible modes of levee failure, four profiles were developed and compared to see which condition produced the highest elevation at a particular reach of the Wisconsin River. Table C-20A shows how the profiles were compared to obtain the critical design water surface profile. Plate C-105 shows this inofrmation in graphic form.

TABLE C-20

PROFILE FOR ALTERNATE A-D

RAISE AND WIDEN PORTAGE LEVEES, CALEDONIA HOLDS, LEWISTON FAILS COMPLETELY

		100-Year	500-Year	SPF
AD	(10)	790.2	790.5	790.6
AE	11	790.4	790.7	790.8
AF	12	790.8	791.0	791.2
AG	13	792.3	792.6	792.7
AH	14	794.0	794.3	794.4
AI	15.5	795.4	795.6	795.8
AJ	16	-	-	-
AK	16.1	796.7	797.0	797.1
AL	16.2	797.1	797.6	797.9
AM	16.5	798.4	798.9	799.2
AN	17.1	799.0	799.4	799.8
AO	17.2	799.2	799.6	800.2
AP	17.8	-	-	-
AQ	17.9	-	-	-
AR	21	799.9	800.3	800.9
AS	22	800.4	800.8	801.4
AT	23	800.5	801.0	802.2
AU	24	800.6	801.4	803.3
AV	27	801.8	802.9	804.2
AW	28	802.5	803.3	804.7
AX	.1	802.8	803.9	804.9
AY	1	803.5	804.7	805.5
AZ	2	804.1	805.1	806.5
BA	3	804.9	805.6	807.0
BB	4	805.8	806.4	807.8
BC	5	806.6	807.3	808.5
BD	6	807.6	808.5	810.0
BE	7	809.5	810.2	812.5
BF	8	811.2	812.0	814.5
BG	9	812.4	813.5	815.9

TABLE C-20A

ALTERNATE A

SELECTED 0.2 PERCENT CHANCE FLOOD LEVEL OF PROTECTION

```
T1    WATER SURFACE PROFILES - WISCONSIN RIVER AT PORTAGE WISCONSIN
T2 RAISE PORTAGE, TPMA4, TPMA2, TPMA1. ALTERNATE A
XL DISTANCE FROM MOUTH X 1000
ID FILENAME: FEWIPAF
```

CROSS SECT NR	DIST FROM MOUTH	THALWEG ELEV LEV EL	500-YR 1/ WAT EL TPMA4	500-YR 2/ WAT EL TPMA2	500-YR 3/ WAT EL TPMA1				TOP OF ROAD ELEV	LOW CHORD ELEV	PORT 4/ TOP OF LEV EL	LEW 4/ TOP OF LEV EL	CAL 4/ TOP OF LEV EL	DESIGN 500 5/ TOP OF LEV EL
10	583.89	765.00	791.90*	790.50	791.00	0.00	0.00	0.00	0.00	0.00	784.50	0.00	0.00	794.90
11	586.80	772.80	792.20*	790.67	791.30	0.00	0.00	0.00	0.00	0.00	786.00	0.00	0.00	795.20
12	588.76	775.00	792.60*	791.09	791.50	0.00	0.00	0.00	0.00	0.00	792.50	0.00	0.00	796.60
13	592.55	772.00	792.90*	792.67	791.80	0.00	0.00	0.00	0.00	0.20	793.50	0.00	0.00	795.30
14	596.10	775.00	793.30	794.30*	792.20	0.00	0.00	0.00	0.00	0.00	797.20	0.00	794.40	797.30
15.5	599.74	775.45	794.10	795.69*	793.00	0.00	0.00	0.00	0.00	0.00	795.80	0.00	796.40	798.70
16	602.36	773.30	794.90	0.00	793.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	803.30	0.00
16.1	602.65	773.30	795.10	796.99*	794.00	0.00	0.00	0.00	807.20	802.30	0.00	0.00	800.00	800.00
16.2	602.76	772.30	795.40	797.59*	794.30	0.00	0.00	0.00	807.20	802.30	0.00	0.00	799.40	800.60
116.5	604.69	775.54	796.20	798.88*	795.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	798.90	801.90
17.1	607.26	773.60	796.70	799.44*	795.50	0.00	0.00	0.00	812.00	804.50	0.00	0.00	799.10	802.40
17.2	607.31	750.00	796.70	799.64*	795.60	0.00	0.00	0.00	812.00	804.50	0.00	0.00	799.30	802.60
17.8	607.34	778.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	799.60	0.00
17.9	607.36	779.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	800.00	0.00
21	611.60	777.70	797.70	800.34*	796.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	799.10	803.30
22	614.30	782.00	798.50	800.82*	797.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	800.20	803.30
23	613.05	783.20	799.70	801.49*	798.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	801.50	804.50
24	623.39	787.39	800.80	802.38*	799.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	805.40
27	628.33	786.90	802.70	803.90*	802.20	0.00	0.00	0.00	0.00	0.00	0.00	804.80	805.79	806.99
28	631.65	787.50	803.40	804.31*	802.70	0.00	0.00	0.00	0.00	0.00	0.00	805.50	806.00	807.30
.1	633.47	787.50	803.70	804.44*	803.00	0.00	0.00	0.00	0.00	0.00	0.00	805.90	807.70	807.40
1	637.17	783.40	804.40	804.70*	803.70	0.00	0.00	0.00	0.00	0.00	0.00	806.40	808.40	807.70
2	639.33	784.00	804.90	805.05*	804.30	0.00	0.00	0.00	0.00	0.00	0.00	808.50	809.20	808.10
3	642.23	788.10	805.70*	805.64	805.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	809.80	808.70
4	645.67	787.20	806.90*	806.50	806.30	0.00	0.00	0.00	0.00	0.00	0.00	809.00	808.90	809.90
5	649.71	788.50	807.70*	807.30	807.20	0.00	0.00	0.00	0.00	0.00	0.00	810.00	808.90	810.70
6	650.54	787.90	808.70*	808.50	808.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	811.70
7	654.24	791.30	810.60*	810.20	810.50	0.00	0.00	0.00	0.00	0.00	0.00	811.20	0.00	813.60
8	658.52	790.00	812.40	812.00	812.60*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	815.60
9	662.24	792.30	813.50	813.20	813.90*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	816.80

EOT..

1. Levee condition corresponding to Alternate A-A (refer to Table C-17), which assumes failure of the Caldgonia levee and Lewiston levee holding. Existing Lewiston levee is not overtopped for this condition.
2. Levee condition corresponding to Alternate A-C (refer to Table C-19), which assumes that the Lewiston and Caledonia levees remain in place but can be overtopped.
3. Levee condition corresponding to Alternate A-B (refer to Table C-18), which assumes that the Lewiston and Caledonia levees have failed to the ground.
4. Existing levee elevations.
5. Design top of levee determined by adding 3 feet to the highest water surface elevation of the three levee conditions shown in this table. Design water surface elevation is designated with an asterick. Levee condition corresponding to Alternate A-D, which assumes that the Caledonia levee holds and the Lewiston levee fails (refer to Table C-20), was not considered in this analysis because the Alternate A-D water surface profile is lower than the water surface profiles (A-A, A-B, A-C) throughout the study reach.

*Controlling (highest) water surface elevation.

FREEBOARD ALLOWANCE

The elevation of the top of the proposed levee for this report is three feet above the design water surface elevation. Freeboard allowance for the design of the levees will be refined further in the General Design Memorandum study and will follow the guidance provided in paragraph 12 of reference 6 and paragraph 3-c of reference 7.

RIPRAP

Riprap was designed according to criteria outlined in EM 1110-2-1601, "Hydraulic Design of Flood Control Channels," and ETL 1110-2-120, "Additional Guidance for Riprap".

The riprap protection was designed for the mode of levee failure which would produce maximum velocities in the Wisconsin River channel adjacent to the proposed levee. This would be the condition where the Lewiston and Caledonia levees remain in place but are overtopped.

During the analysis it was found that the required size of riprap for each particular alternate would be the same regardless of whether the level of protection was the 1-percent, 0.2-percent or the SPF event. The reason for this is that the amount of discharge in the Wisconsin River channel, where riprap is required, depends upon the height of the Lewiston and Caledonia levees, which are overtopped for all three events. The difference in discharge in the Wisconsin River, where riprap is required, between the SPF and the 1-percent event is approximately 10,000 cubic feet per second. Sample calculations are provided at the end of this appendix.

CHANNEL STABILITY

Channel erosion is not considered a significant problem in the study area. Most of the soils are classified as alluvial, which is generally very slightly erodible. Throughout the Wisconsin River basin it has been estimated there are about 1,170 miles of eroded streambank on perennial streams. Within Columbia County only 13 miles (approximately 1 percent of the total mileage) was estimated to have erosion.

The sediment yield rate for the entire basin is low, ranging from less than 0.01 to 0.30 acre-foot per square mile annually. Within Columbia County the figure runs from 0.01 to 0.10 acre-foot per square mile per year. The available information indicates that sedimentation does not appear to be a serious problem.

Plate 102 shows plotted data points of recorded elevations for historical floods. The plotted points indicate that there has been a trend toward increased stage for a given discharge, indicating that over the years there has been some channel aggradation, at least for the reach of the Wisconsin River in the vicinity of the Portage gage. The amount of aggradation is minimal however, as can be seen by comparing 1951-1969 data to 1888-1905 data.

OPERATION AND MAINTENANCE

Functional Operation

The only operation relative to hydraulic design is the construction and operation of one railroad closure. For a standard project flood on the Wisconsin River, the flow increases from base flow to the discnarge when closure must occur in 3½ days (see Appendix B, Plate B-21). This time frame will have to be considered when designing the closure structure.

Maintenance

No channel maintenance of the Wisconsin River is anticipated. As discussed in the paragraph on channel stability, observed aggradation over the period of record has been minimal. The expected aggradation could be handled within the freeboard allowance.

VELOCITIES

Channel velocities in the Wisconsin River for a particular flood event would depend upon the mode of levee failure of the Lewiston and Caledonia levees. The levee condition that would produce the maximum velocities in

the Wisconsin River channel for a particular flood event would be where the Lewiston and Caledonia levees remain in place but are overtopped. See Table C-21 for a list of the Wisconsin River channel velocities for the Standard Project Flood event.

TABLE C-21

WISCONSIN RIVER
STANDARD PROJECT FLOOD VELOCITIES

Cross-Section	Velocity Feet Per Second
AD	
AE (11)	1.05
AF (12)	1.07
AG (13)	1.57*
AH (14)	4.99*
AI (15.5)	3.77*
AJ (16)	8.32*
AK 16.1	10.0*
AL 16.2	10.0*
AM 116.5	5.53*
AS 22	0.00
AT 23	0.76
AU 24	0.73
AV 27	0.59
AW 28	0.45
AX .1	0.47
AY 1	0.63
AZ 2	
BA 3	
BB 4	
BC 5	
BD 6	
BE 7	
BF 8	
BG 9	

SAMPLE CALCULATION

TABLE C-22 shows sample computations for the riprap design. See "Riprap Design" paragraph for further discussion on design discharge.

TABLE C-22

```
1                                722-F5-F5260 OUTPUT
                    RUN DATE : 7 DEC 82 RUN TIME:   8:52:50

      PORTAGE

      CROSS-SECTION NUMBER:               15.500
      NUMBER OF SUBSECTIONS:                  13
      WATER SURFACE ELEVATION:            796.40
      TOTAL DISCHARGE:                     90000 CFS
      DISCHARGE SUMMATION:               90000.0 CFS
      AREA SUMMATION:                   25466.65 SF
      AVERAGE VELOCITY:                     3.53 FPS

                    SPECIFIC WEIGHT OF STONE=  165 PCF

                               RIPRAP GRADATION
                         LAYER THICKNESS = 12 INCHES

                    PERCENT LIGHTER       LIMITS OF STONE
                    BY WEIGHT (SSD)        WEIGHT - LBS

                          100                 86     35
                           50                 26     17
                           15                 15      5

1                                722-F5-F5260 OUTPUT
                    RUN DATE : 7 DEC 82 RUN TIME:   9:00:27

                      ==============================
                      =RESULTS OF THE ALPHA METHOD=
                      ==============================

                    XDIST         DD          AREA          K          P
      SUBSECTION      R          R/K           C            Q          V
        NUMBER       1/2         1/2         1/2 3         3/2
                     CR        (CR  )A     (CR  ) A     (CR  )A

                    47.00        7.90        371.30        0.56      49.58
            1        7.49       12.91         71.03      935.09       2.52
                      196       72781     279651777      545004
```

```
MEAN ENERGY SLOPE =                 0.0001653 FT/FT
MEAN HYDRAULIC RADIUS =                 13.16 FT
AVERAGE SHEAR STRESS =                   0.14 PSF
ENERGY CORRECTION FACTOR (ALPHA):       1.19

ALPHA NEGLECTED:
MEAN C =                                75.77
EFFECTIVE K =                            0.76 FT
MANNING'S N =                           0.030

ALPHA CONSIDERED:
MEAN C =                                62.61
EFFECTIVE K =                            0.47 FT
MANNING'S N =                           0.028


                        ===========================
                        -SHEAR STRESS COMPUTATIONS-
                        ===========================

BEND COMPUTATIONS:


FOR OUTSIDE OF BEND-

AVERAGE SHEAR STRESS=               0.14 PSF
R/W =                               4.31
SHEAR STRESS RATIO TB/TO =          1.49
BEND SHEAR STRESS TB =              0.28 PSF
K1 =                               0.871
DESIGN SHEAR STRESS T =             2.08 PSF
BEND VELOCITY =                     4.32 FPS

DESIGN SHEAR STRESS EXCEEDS BEND SHEAR STRESS
LESSER LAYER THICKNESS CAN BE TRIED


FOR LEFT BANK

K2 =                                0.01530
LOCAL BOUNDARY SHEAR STRESS TO =      0.57 PSF
K1 =                                  0.871
DESIGN SHEAR STRESS T =               2.08 PSF

DESIGN SHEAR STRESS EXCEEDS LOCAL BOUNDARY SHEAR STRESS
LESSER LAYER THICKNESS CAN BE TRIED
```

	489.00	12.95	6332.55	0.50	489.05
2	12.95	25.90	81.49	23877.73	5.77
	293	1856915	***********	24045420	
	100.00	11.00	1100.00	0.50	100.02
3	11.00	22.00	79.10	3714.06	3.38
	262	208633	1991393600U	3176633	
	60.00	8.65	519.00	0.50	60.35
4	6.60	17.20	75.69	1461.38	2.05
	221	115203	5676215760	990711	
	622.00	5.30	3296.60	0.50	622.00
5	5.30	10.60	68.84	6716.12	2.04
	158	522452	13122250041	2760990	
	14.00	8.70	121.80	0.50	15.65
6	7.76	15.56	74.28	324.52	2.00
	207	25256	1083470968	196561	
	181.00	15.50	2805.50	0.50	181.12
7	15.49	30.98	84.02	11929.93	4.25
	330	927762	***********	14370700	
	55.00	19.85	1091.75	0.50	55.04
8	19.04	39.67	67.55	5472.44	5.01
	389	425579	64668765097	6441594	
	100.00	20.75	2075.00	0.50	100.00
9	20.75	41.50	68.16	10715.60	5.15
	401	833327	***********	17291465	
	61.00	13.10	799.10	0.50	62.62
10	12.72	25.44	61.24	2977.24	3.73
	209	231532	19437309635	2945539	
	388.00	8.60	3336.80	0.50	388.05
11	8.60	17.20	75.69	9525.65	2.05
	221	740632	30467794343	6366676	
	280.00	11.75	3290.00	0.50	280.00
12	11.75	23.50	60.11	11617.53	3.53
	274	903468	68131388723	10615748	
	55.00	5.95	327.25	0.50	56.27
13	5.02	11.63	70.15	711.91	2.18
	169	55363	1504586564	321964	

ALTERNATE PLAN CONSIDERED

GENERAL

Besides the selected plan, another plan was studied by approximate methods that would prevent all Fox River overflow up to the Standard Project Flood. For this plan the existing Portage levee would be raised and widened and a new levee 5.1 miles long would be developed in the Lewiston township area. The Portage levee would have all of the same features of the Portage levee alternative except that the height and width of the levee would be increased and additional modification would occur at the Portage lock and downstream of Portage. The Lewiston levee would be needed to prevent overflows into the Fox River basin. No work would be done on the existing Caledonia levees.

DEGREE OF PROTECTION

The proposed Lewiston and Portage levees would provide protection against flood events up to the Standard Project Flood in the city of Portage. There would also be no Wisconsin River flow over the Lewiston levee and down the Fox River at least for flood flows on the Wisconsin River up to and including the Standard Project Flood Event.

FEATURES OF THE ALTERNATE PLAN

The specific features of this alternate plan are included in the Plan Formulation Appendix.

METHOD OF ANALYSIS AND IMPACT EVALUATION

General

For this plan the two possible failure modes of the existing Caledonia levees were analyzed with respect to their impact on flood flows, stage and frequency. The failure modes were not studied in

detail. Engineering judgment was used to modify computer runs and back-up data developed in the detailed analysis of levee conditions one through five to determine a reasonable representation of the two possible levee failure modes. For each failure mode the following was determined: (1) Discharge-frequency curves at cross section AD (see Appendix B for discussion), (2) Discharge-frequency curves downstream of the mouth of the Baraboo River (see Appendix B for discussion), (3) Water surface profiles for the 1-percent, 0.2-percent exceedence frequencies and the SPF events were developed throughout the study reach, (4) Approximate peak stages in the lateral reservoirs (Caledonia Reservoir and the Fox River Swamp Reservoir) for flood events with exceedence frequencies of 10-percent, 2-percent, 1-percent, 0.2-percent and the SPF event.

For this alternate there would be no Lewiston levee overflow and peak elevations in the Lewiston reservoirs did not have to be determined.

For this alternate there would be no Portage levee overflow and the peak elevations in the Fox River Swamp area (the elevation in the Ward 1 area of Portage is the same as that in the Fox River Swamp) were determined based upon coincident flow on the Fox River and the rating curve developed for the Fox River Swamp outlet.

For the Caledonia levees fail completely condition, the Caledonia reservoir becomes part of the Wisconsin River floodway. The elevation at each cross section would be determined by the Wisconsin River water surface profile.

For the Caledonia levees do not fail but could be overtopped condition, the elevations in the Caledonia reservoir were determined by routing the Wisconsin River overflows through the Caledonia reservoir using the modified Puls method.

The assumed levee failure conditions will be identified as follows:

Alternate B-A - Caledonia Levee Fails Completely.

Alternate B-B - Caledonia Levee Overtopped but Does Not Fail.

Alternate B-A - Caledonia Levee Fails Completely

The flow condition for this levee alignment is the same as the selected plan Alternate A-A, "Complete failure of the Caledonia Levee with the Lewiston Levee holding." See selected plan Alternative A-A for a discussion of the method of analysis. See Table C-23 for peak stages in the lateral reservoirs for this alternate. See Table C-24 for tabulation of Wisconsin River water surface profile elevations for the 1-percent, 0.2-percent and SPF events throughout the study reach. See Plate C-103 for elevation frequency curves showing peak elevations in the lateral reservoirs for Alternate B-A.

The flooded outline would approximately be the same for the 1-percent, 0.2-percent and SPF events. The outline would extend from the levees in the left overbank over to the Interstate 94 roadway in the upper reaches (upstream of TH 78) and over to the Baraboo River in the lower reaches.

TABLE C-23

ALTERNATIVE B - RAISE AND WIDEN THE PORTAGE LEVEES AND A NEW LEWISTON LEVEE

Approximate Peak Stages in the Lateral Reservoirs
for each of the Alternate Conditions Footnoted

	Alternate Condition B-A[1]					Alternate Condition B-B[2]				
Lateral Reservoir Location	10%	2%	1%	0.2%	SPF	10%	2%	1%	0.2%	SPF
Caledonia Reservoir	□	(Cross section AM) □	□	□	□					
Peak Elevation			794.6	796.2	797.36			794.8	795.2	796.3
Fox River Swamp Reservoir	782.6	783.5	793.8	784.2	785.0	782.6	783.5	793.8	784.2	785.0

Footnotes:
Alternate Conditions:
1. Caledonia Levee Fails Completely
2. Caledonia Levee Overtopped but Does Not Fail

□ For this condition, the reservoir is in the Wisconsin River Floodway.

Comment:
For this alternate, there will be no overflow into the Lewiston or Fox River Reservoirs. The elevation in the Fox River Swamp will be determined by the coincident Fox River Discharge.

TABLE C-24

PROFILE FOR ALTERNATE B-A

CALEDONIA LEVEE FAILS COMPLETELY

WATER SURFACE PROFILE - WISCONSIN RIVER AT PORTAGE

	100-Year	500-Year	SPF
AD (10)	790.25	791.90	794.03
AE 11	790.64	792.20	794.36
AF 12	790.96	792.60	794.65
AG 13	791.29	792.90	794.89
AH 14	791.72	793.30	795.20
AI 15.5	792.45	794.10	705.74
AJ 16	793.34	794.90	796.41
AK 16.1	793.51	795.10	796.59
AL 16.2	793.77	795.40	796.66
AM 16.5	794.60	796.20	797.36
AN 17.1	795.05	796.70	797.75
AO 17.2	795.08	796.70	797.76
AP 17.8	0.00	0.00	0.00
AQ 17.9	0.00	0.00	0.00
AR 21	796.10	797.70	798.64
AS 22	796.91	798.50	799.43
AT 23	798.31	799.70	800.93
AU 24	799.72	800.80	802.50
AV 27	801.61	802.70	804.41
AW 28	802.33	803.40	805.12
AX .1	802.64	803.70	805.48
AY 1	803.30	804.40	806.24
AZ 2	803.77	804.90	806.72
BA 3	804.59	805.70	807.69
BB 4	805.81	806.90	809.07
BC 5	806.57	807.70	809.89
BD 6	807.56	808.70	810.93
BE 7	809.54	810.60	813.05
BF 8	811.31	812.40	814.81
BG 9	812.44	813.50	815.96

Alternate B-B - Caledonia Levees Overtopped but Does Not Fail

This alternate was analyzed as a modification of Existing Conditions Levee Condition 2. The water surface profiles and flow into the Caledonia Reservoir is controlled by the height of the Caledonia levees. For each flood event, a trail and error procedure was used which consisted of assuming a water surface profile, estimating a Caledonia levee overflow based upon the assumed water surface profile and then checking that the assumed profile corresponded to the discharge which remains in the Wisconsin River after the Caledonia levee overflow. The channel geometry is the same as existing condition, Levee Condition 2. See Table C-23 for peak stages in the lateral reservoirs for this alternate. See Table C-25 for tabulation of Wisconsin River water surface profile elevations for the 1-percent, 0.2-percent and Standard Project Flood events throughout the study reach. See Plate C-104 for elevation frequency curves showing peak elevations in the lateral reservoirs for Alternate B-B. The flooded outline for all flood flows would extend from the Lewiston and Portage levees in the left overbank over to the Caledonia levees in the right overbank. The Caledonia levees would be overtopped for the 1-percent, 0.2-percent and Standard Project Flood events and the flooded outline would also include the Caledonia Reservoir area.

The flooded outline in the Caledonia Reservoir area for all three events would be approximately the same as the existing conditions, Levee Condition 2, Standard Project Flood event.

FREEBOARD ALLOWANCE

The elevation of the top of the proposed levee for this report is three feet above the design water surface elevation. Freeboard allowance for the design of the levees will be refined further in the General Design Memorandum study and will follow the guidance provided in paragraph 12 of reference 6 and paragraph 3-c of reference 7.

TABLE C-25

PROFILE FOR ALTERNATE B-B

CALEDONIA LEVEE OVERTOPPED BUT DOES NOT FAIL

WATER SURFACE PROFILE - WISCONSIN RIVER AT PORTAGE

	100-Year	500-Year	SPF
AD (10)	790.70	791.00	791.60
AE 11	790.90	791.17	791.77
AF 12	791.30	791.59	792.19
AG 13	792.80	793.07	793.69
AH 14	794.50	794.80	795.44
AI 15.5	795.90	706.20	796.89
AJ 16	0.00	0.00	0.00
AK 16.1	797.20	707.50	798.14
AL 16.2	707.60	797.90	798.94
AM 16.5	798.90	799.20	800.23
AN 17.1	799.50	799.70	800.80
AO 17.2	799.70	800.10	801.20
AP 17.8	0.00	0.00	0.00
AQ 17.9	0.00	0.00	0.00
AR 21	800.40	800.84	801.80
AS 22	800.65	801.07	802.11
AT 23	801.00	801.50	802.65
AU 24	801.70	802.40	803.56
AV 27	803.10	803.90	805.22
AW 28	803.50	804.30	805.71
AX .1	803.60	804.40	805.87
AY 1	803.80	804.70	806.15
AZ 2	804.20	805.10	806.53
BA 3	804.90	805.60	807.04
BB 4	805.80	806.50	807.76
BC 5	806.60	807.30	808.53
BD 6	807.60	808.50	810.01
BE 7	809.50	810.20	812.50
BF 8	811.30	812.00	814.50
BG 9	812.60	813.20	815.89

RIPRAP

Riprap was designed according to criteria outlined in EM 1110-2-1601, "Hydraulic Design of Flood Control Channels," and ETL 1110-2-120, "Additional Guidance for Riprap".

The riprap protection was designed for the mode of levee failure which would produce maximum velocities in the Wisconsin River channel adjacent to the proposed levee. This would be the condition where the Caledonia levees remain in place but are overtopped.

During the analysis it was found that the required size of riprap for each particular alternate would be the same regardless of whether the level of protection was the 1-percent, 0.2-percent or the SPF event. The reason for this is that the amount of discharge in the Wisconsin River channel, where riprap is required, depends upon the height of the Caledonia levees, which are overtopped for all three events. The difference in discharge in the Wisconsin River, where riprap is required, between the SPF and the 1-percent event is approximately 10,000 cubic feet per second. Sample calculations are provided at the end of this appendix.

CHANNEL STABILITY

Channel erosion is not considered a significant problem in the study area. Most of the soils are classified as alluvial, which is generally very slightly erodible. Throughout the Wisconsin River basin it has been estimated there are about 1,170 miles of eroded streambank on perennial streams. Within Columbia County only 13 miles (approximately 1 percent of the total mileage) was estimated to have erosion.

The sediment yield rate for the entire basin is low, ranging from less than 0.01 to 0.30 acre-foot per square mile annually. Within Columbia County the figure runs from 0.01 to 0.10 acre-foot per square mile per year. The available information indicates that sedimentation does not appear to be a serious problem.

Plate 102 shows plotted data points of recorded elevations for historical floods. The plotted points indicate that there has been a trend toward increased stage for a given discharge, indicating that over the years there has been some channel aggradation, at least for the reach of the Wisconsin River in the vicinity of the Portage gage. The amount of aggradation is minimal however, as can be seen by comparing 1951-1969 data to 1888-1905 data.

OPERATION AND MAINTENANCE

Functional Operation

The only operation relative to hydraulic design is the construction and operation of one roadway and one railroad closure. For a standard project flood on the Wisconsin River, the flow increases from base flow to the discharge when closure for both structures must occur is 3½ days (see Appendix B, Plate B-21). This time frame will have to be considered when designing the closure sturcture.

Maintenance

No channel maintenance of the Wisconsin River is anticipated. As discussed in the paragraph on channel stability, observed aggradation over the period of record has been minimal. The expected aggradation could be handled within the freeboard allowance.

VELOCITIES

Channel velocities in the Wisconsin River for a particular flood event would depend upon the mode of levee failure of the Caledonia levees. The levee condition that would produce the maximum velocities in the Wisconsin River channel for a particular flood event would be where the Caledonia levees remain in place but are overtopped. See Table C-26 for a list of the Wisconsin River channel velocities for the Standard Project Flood event.

TABLE C-26

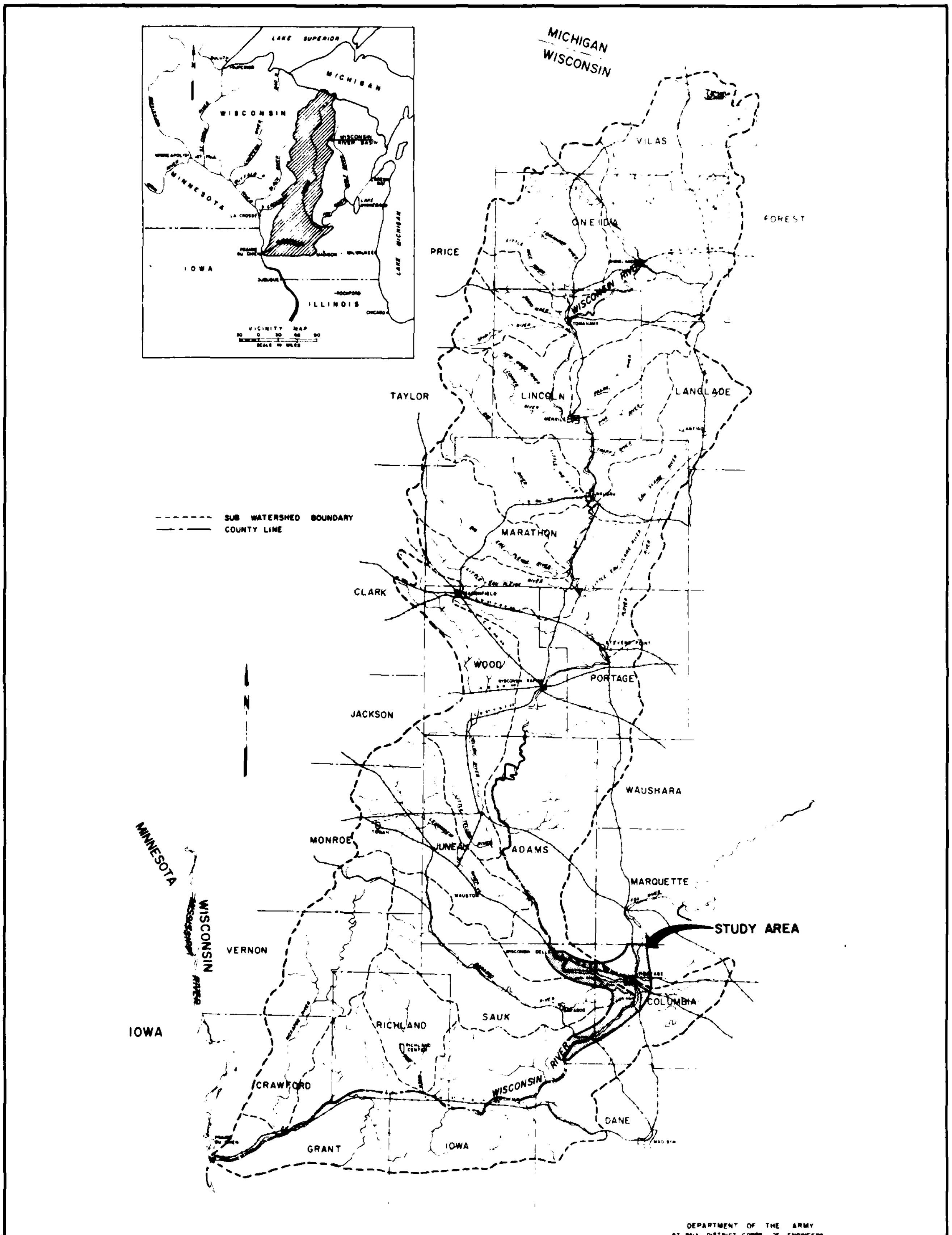
WISCONSIN RIVER

STANDARD PROJECT FLOOD VELOCITIES

Cross-Section	Velocity Feet Per Second
AD	
AE (11)	1.05
AF (12)	1.07
AG (13)	1.57*
AH (14)	4.99*
AI (15.5)	3.77*
AJ (16)	8.32*
AK 16.1	10.0*
AL 16.2	10.0*
AM 116.5	5.53*
AS 22	0.00
AT 23	0.76
AU 24	0.73
AV 27	0.59
AW 28	0.45
AX .1	0.47
AY 1	0.63
AZ 2	
BA 3	
BB 4	
BC 5	
BD 6	
BE 7	
BF 8	
BG 9	

SAMPLE CALCULATION

Table C-22 shows sample computations for the riprap design. See "Riprap Design" paragraph for further discussion on design discharge.



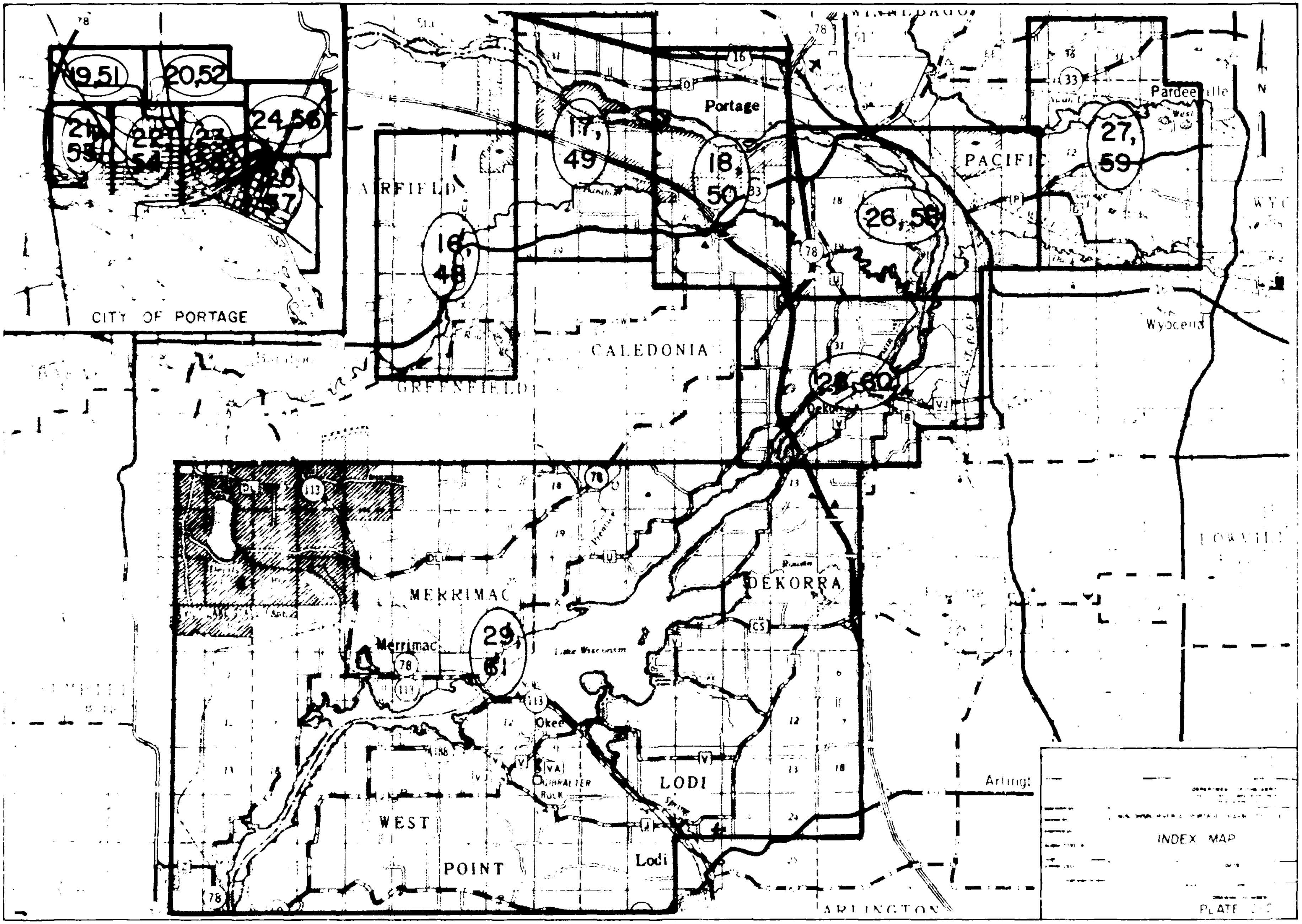
WISCONSIN RIVER WATERSHED

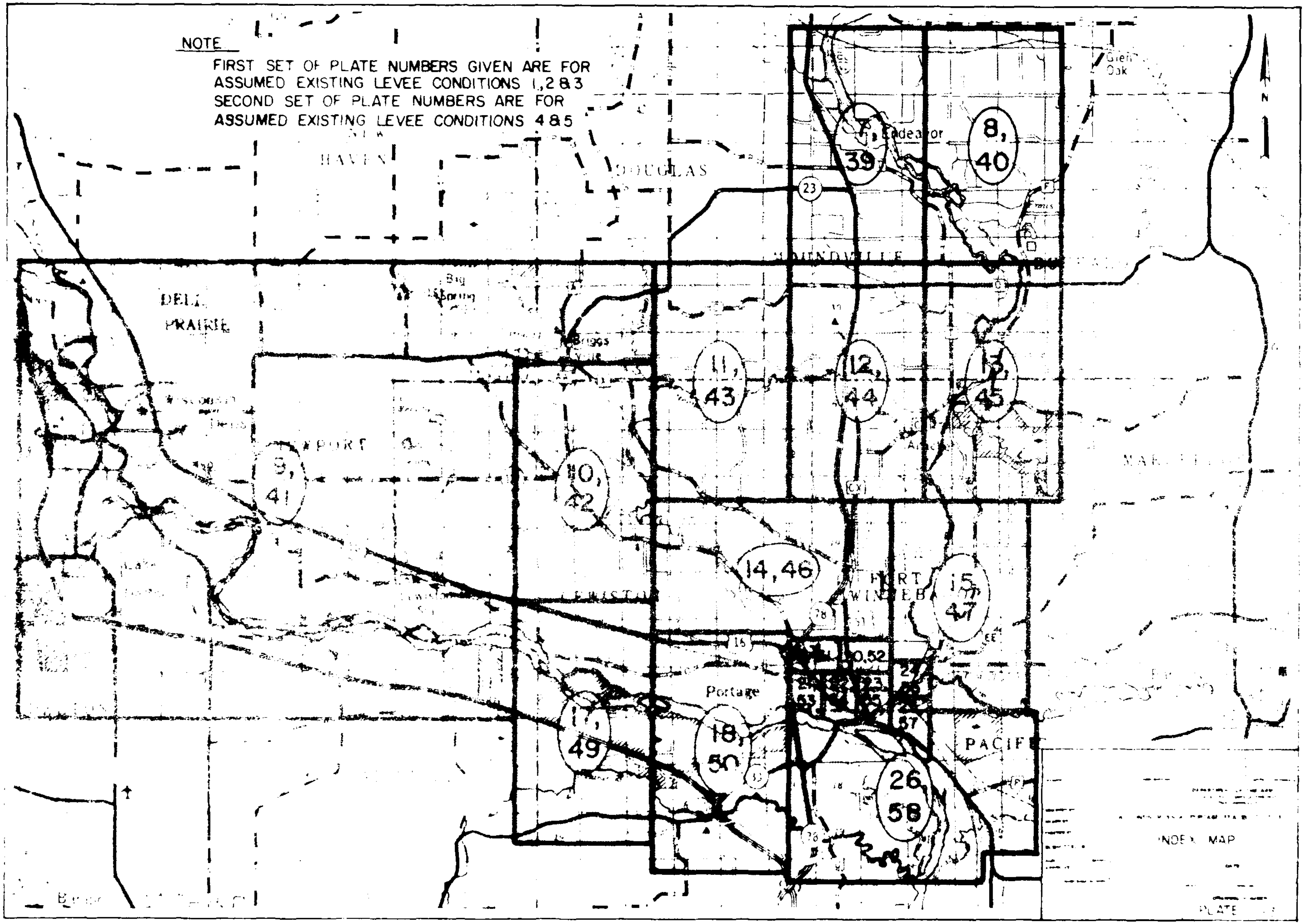
SCALE IN MILES

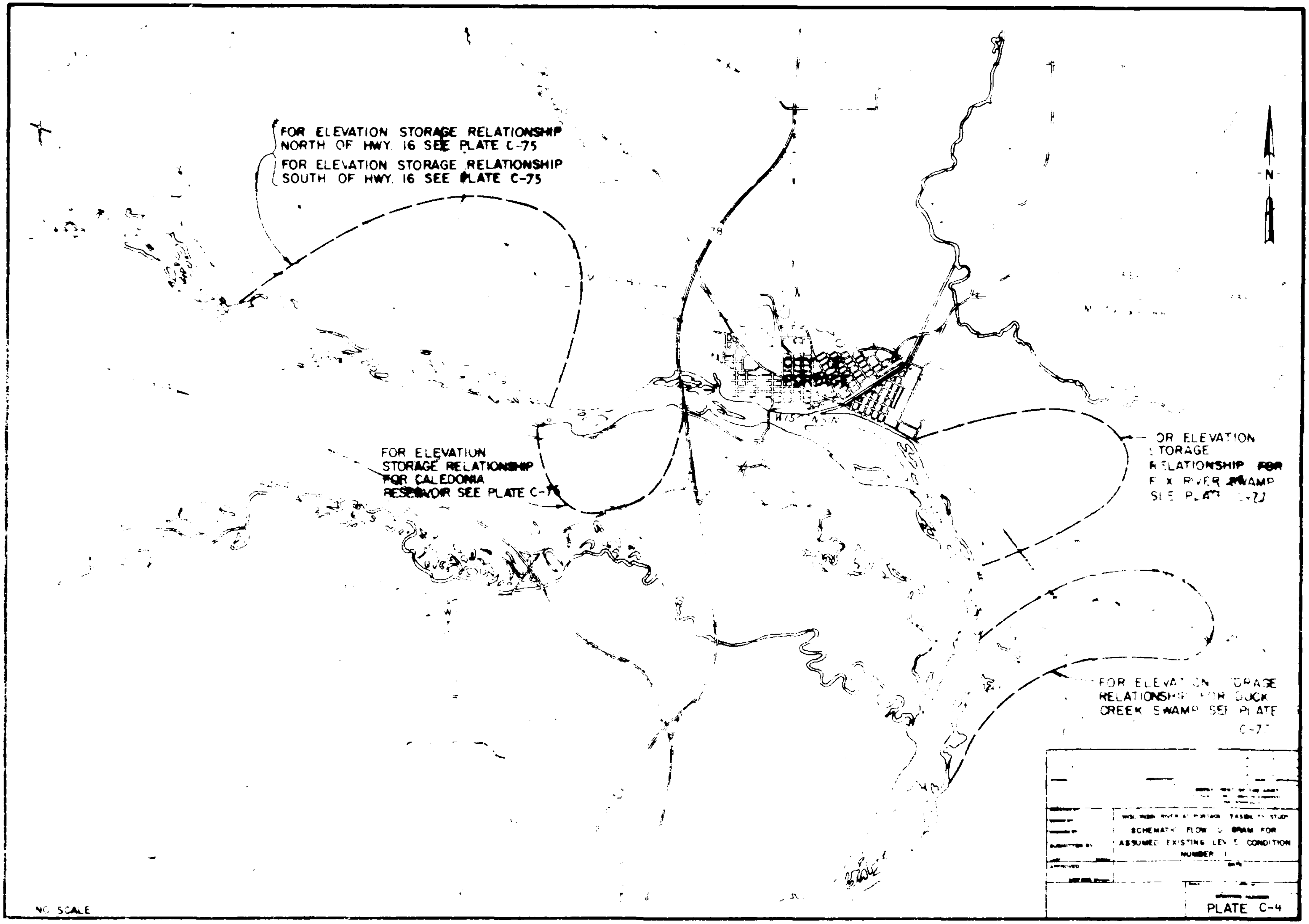
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

WATERSHED MAP

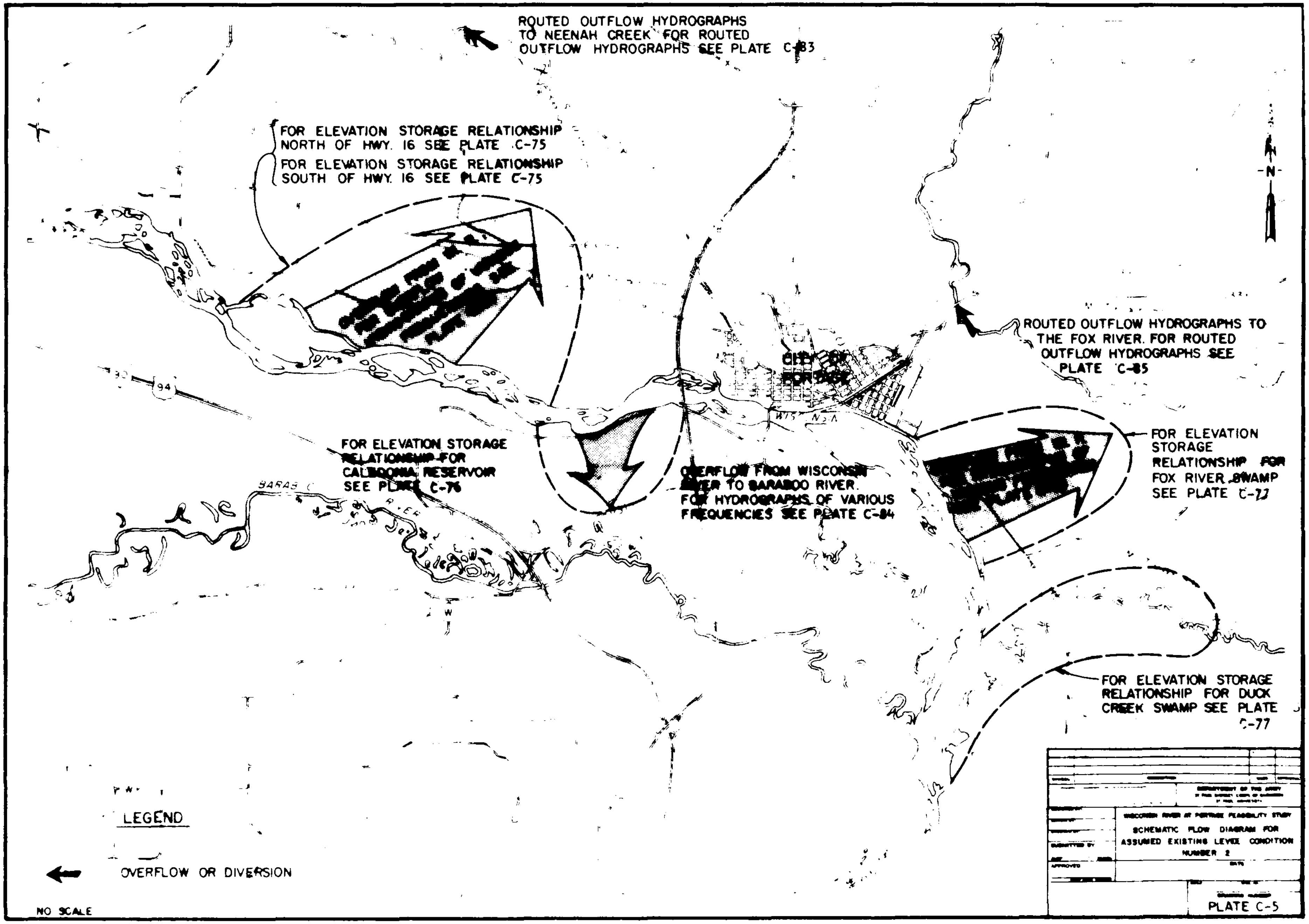
WISCONSIN RIVER
VICINITY OF PORTAGE, WISCONSIN
MARCH 1980

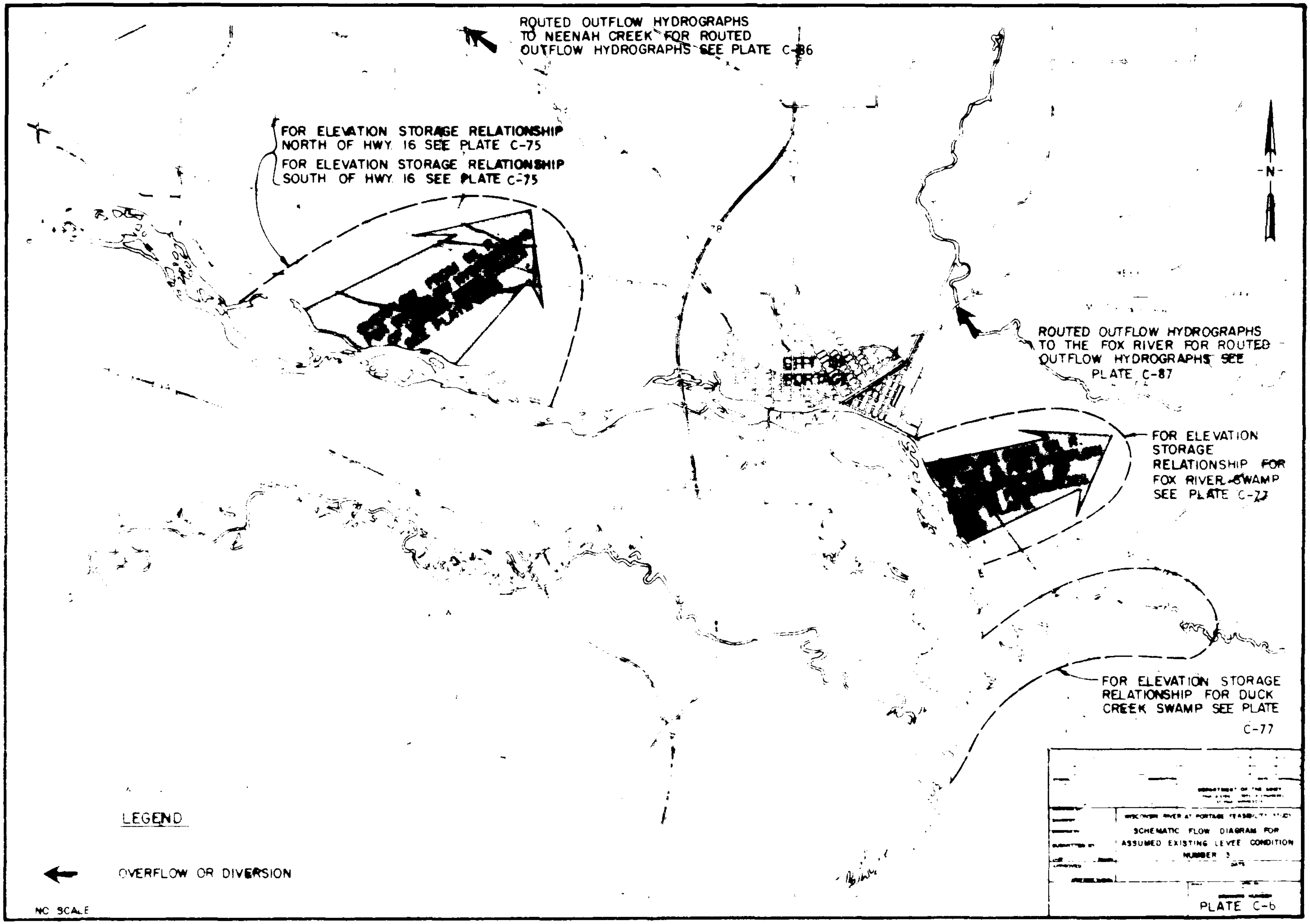

CITY OF PORTAGE
19,51
20,52
24,56
Portage
PACIFIC
27, 59
Pardeeville
17, 49
18, 50
26, 58
16, 48
CALEDONIA
GREENFIELD
Wyocena
28, 60
MERRIMAC
DEKORRA
29, 61
Merrimac
Lake Wisconsin
Okee
LODI
Lodi
WEST POINT
ARLINGTON
LOWVILLE
INDEX MAP
PLATE
N


NOTE
FIRST SET OF PLATE NUMBERS GIVEN ARE FOR ASSUMED EXISTING LEVEE CONDITIONS 1,2 & 3
SECOND SET OF PLATE NUMBERS ARE FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5
DELL PRAIRIE
HAVEN
DOUGLAS
Portage
PACIFIC
FORT WINNEBAGO
Glen Oak
Big Spring
7, 39
8, 40
9, 41
10, 42
11, 43
12, 44
13, 45
14, 46
15, 47
17, 49
18, 50
26, 58
INDEX MAP
PLATE

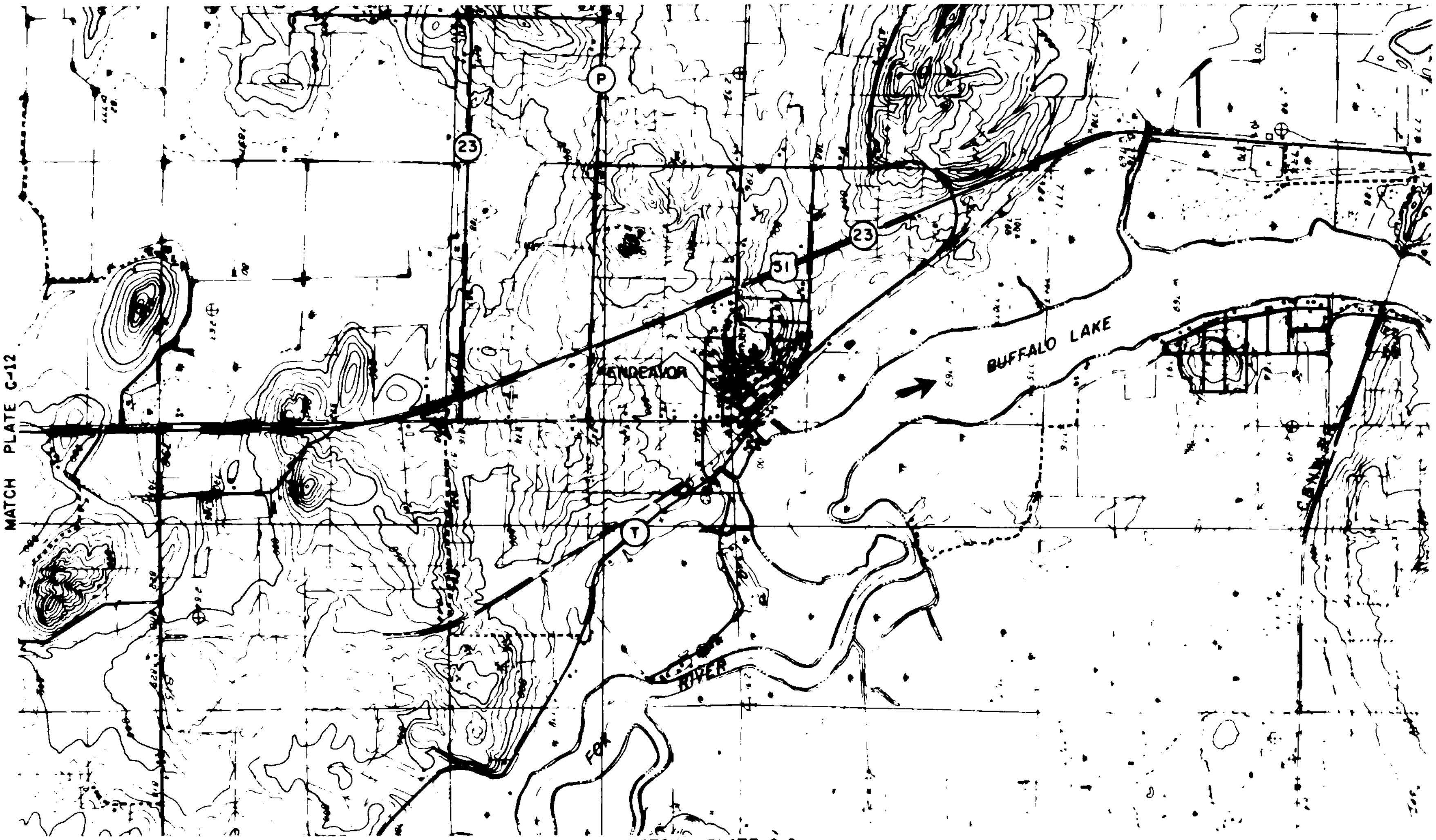


N
FOR ELEVATION STORAGE RELATIONSHIP NORTH OF HWY. 16 SEE PLATE C-75
FOR ELEVATION STORAGE RELATIONSHIP SOUTH OF HWY. 16 SEE PLATE C-75
FOR ELEVATION STORAGE RELATIONSHIP FOR CALEDONIA RESERVOIR SEE PLATE C-76
SCHEMATIC FLOW
ASSUMED EXISTING
CONDITION
NUMBER 1
NO SCALE
PLATE C-4


ROUTED OUTFLOW HYDROGRAPHS TO NEENAH CREEK FOR ROUTED OUTFLOW HYDROGRAPHS SEE PLATE C-83
FOR ELEVATION STORAGE RELATIONSHIP NORTH OF HWY. 16 SEE PLATE C-75
FOR ELEVATION STORAGE RELATIONSHIP SOUTH OF HWY. 16 SEE PLATE C-75
-N-
ROUTED OUTFLOW HYDROGRAPHS TO THE FOX RIVER. FOR ROUTED OUTFLOW HYDROGRAPHS SEE PLATE C-85
FOR ELEVATION STORAGE RELATIONSHIP FOR CALEDONIA RESERVOIR SEE PLATE C-76
OVERFLOW FROM WISCONSIN RIVER TO BARABOO RIVER. FOR HYDROGRAPHS OF VARIOUS FREQUENCIES SEE PLATE C-84
FOR ELEVATION STORAGE RELATIONSHIP FOR FOX RIVER SWAMP SEE PLATE C-77
FOR ELEVATION STORAGE RELATIONSHIP FOR DUCK CREEK SWAMP SEE PLATE C-77
94
LEGEND
OVERFLOW OR DIVERSION
NO SCALE
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
SCHEMATIC FLOW DIAGRAM FOR ASSUMED EXISTING LEVEE CONDITION NUMBER 2
PLATE C-5



ROUTED OUTFLOW HYDROGRAPHS TO NEENAH CREEK FOR ROUTED OUTFLOW HYDROGRAPHS SEE PLATE C-86
FOR ELEVATION STORAGE RELATIONSHIP NORTH OF HWY. 16 SEE PLATE C-75
FOR ELEVATION STORAGE RELATIONSHIP SOUTH OF HWY. 16 SEE PLATE C-75
N
ROUTED OUTFLOW HYDROGRAPHS TO THE FOX RIVER FOR ROUTED OUTFLOW HYDROGRAPHS SEE PLATE C-87
FOR ELEVATION STORAGE RELATIONSHIP FOR FOX RIVER SWAMP SEE PLATE C-77
FOR ELEVATION STORAGE RELATIONSHIP FOR DUCK CREEK SWAMP SEE PLATE C-77
LEGEND
OVERFLOW OR DIVERSION
NO SCALE
SCHEMATIC FLOW DIAGRAM FOR ASSUMED EXISTING LEVEE CONDITION
NUMBER 3
PLATE C-6



MATCH PLATE C-8

LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 2

(100 YR)

(SPF)

CONDITION 3

(100 YR)

(SPF)

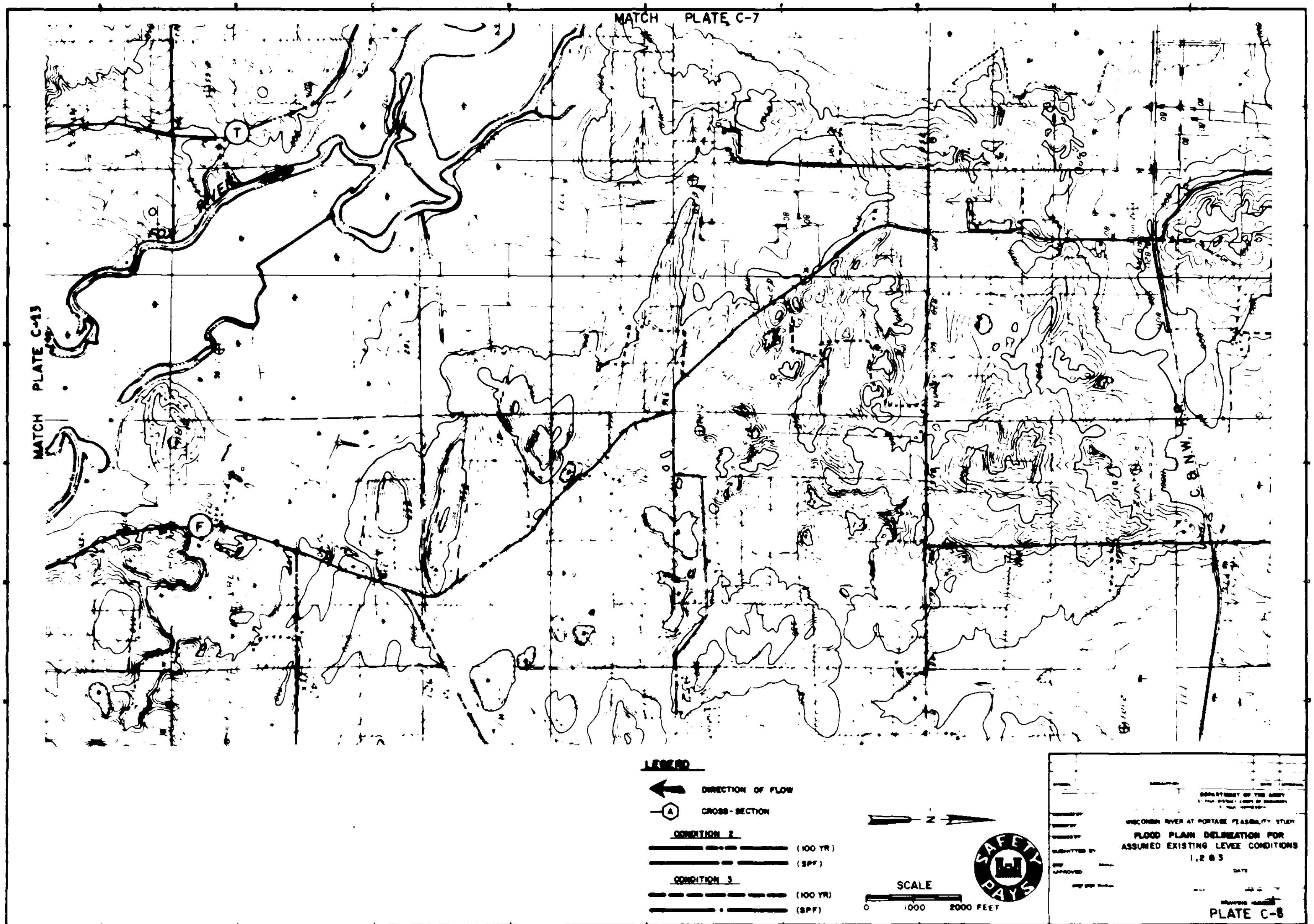
N

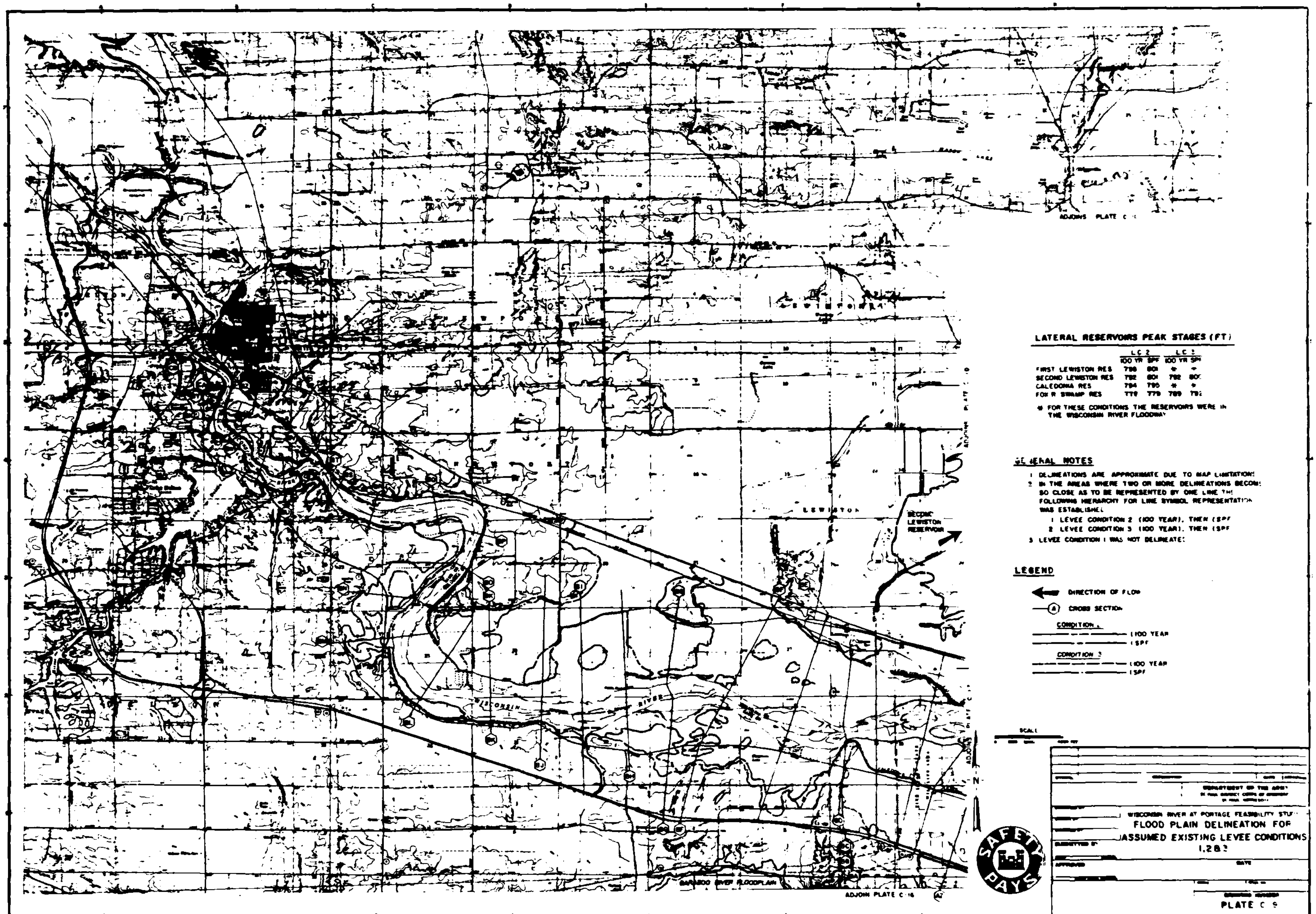
SCALE

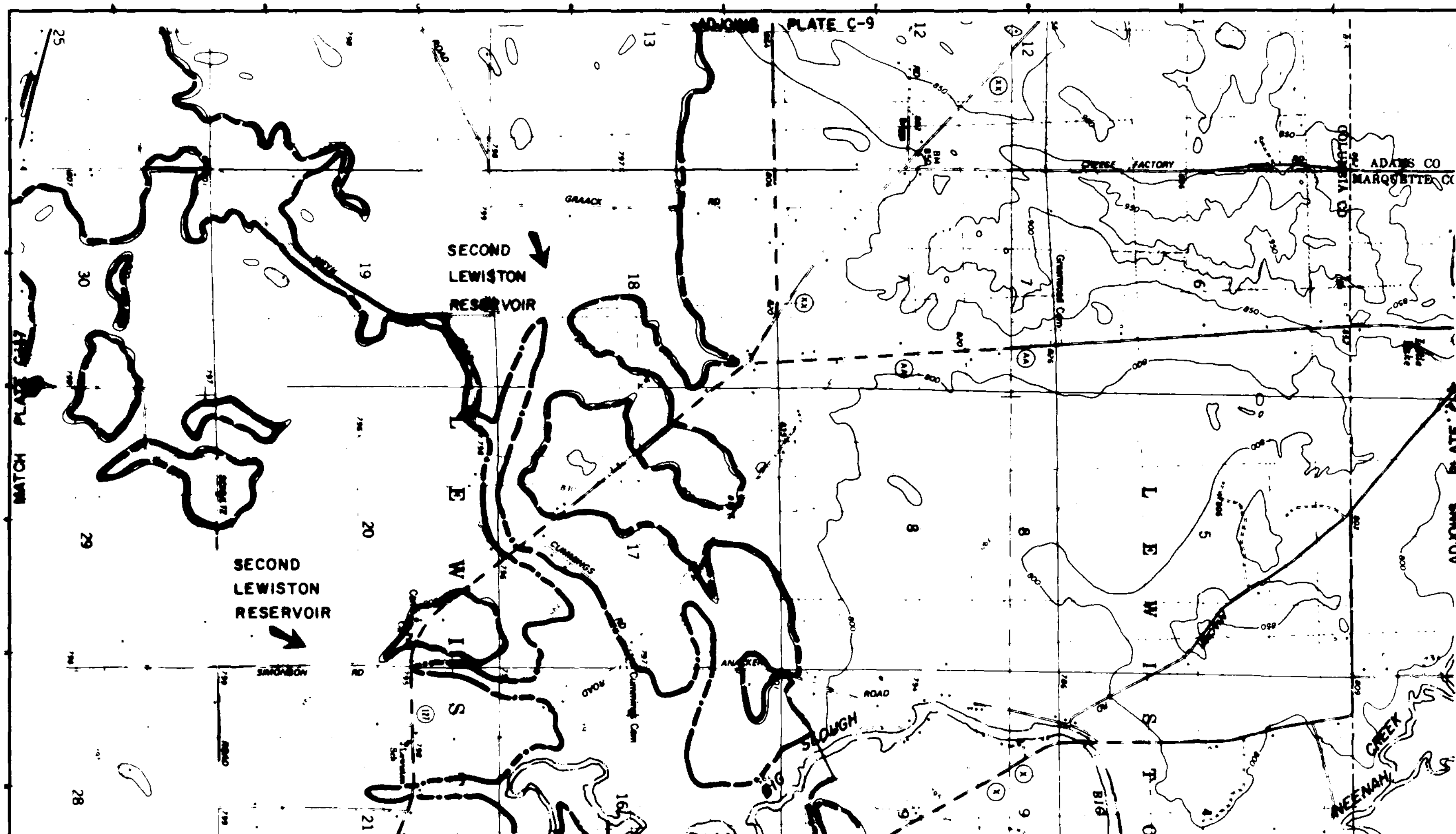
0 1000 2000 FEET

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

PLATE


MATCH PLATE C-7
MATCH PLATE C-13
C & N.W. R.R.
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 2
(100 YR)
(SPF)
CONDITION 3
(100 YR)
(SPF)
N
SCALE
0 1000 2000 FEET
SAFETY PAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
1, 2 & 3
PLATE C-8


LATERAL RESERVOIRS PEAK STAGES (FT)
	LC 2		LC 3	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	798	801	*	*
SECOND LEWISTON RES	792	801	792	80[illegible]
CALEDONIA RES	794	795	*	*
FOX R SWAMP RES	778	779	789	79[illegible]
* FOR THESE CONDITIONS THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY
GENERAL NOTES
1 DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2 IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
1 LEVEE CONDITION 2 (100 YEAR), THEN (SPF
2 LEVEE CONDITION 3 (100 YEAR), THEN (SPF
3 LEVEE CONDITION 1 WAS NOT DELINEATED
LEGEND
DIRECTION OF FLOW
CROSS SECTION
CONDITION 2
(100 YEAR
(SPF
CONDITION 3
(100 YEAR
(SPF
SCALE
SECOND LEWISTON RESERVOIR
LEWISTON
WISCONSIN RIVER
BARABOO RIVER FLOODPLAIN
ADJOIN PLATE C-16
ADJOINS PLATE C-11
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
1,2&3
PLATE C-9



MATCH PLATE C-14 MATCH PLATE C-11

GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 2 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LATERAL RESERVOIRS PEAK STAGES (FT.)

	L.C. 2		L.C. 3	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	796	801	*	*
SECOND LEWISTON RES	792	801	792	800
CALEDONIA RES	794	795	*	*
FOX R. SWAMP RES.	776	779	789	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY.

LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 2

(100 YR)

(SPF)

CONDITION 3

(100 YR)

(SPF)

N

SCALE

0 1000 2000 FEET

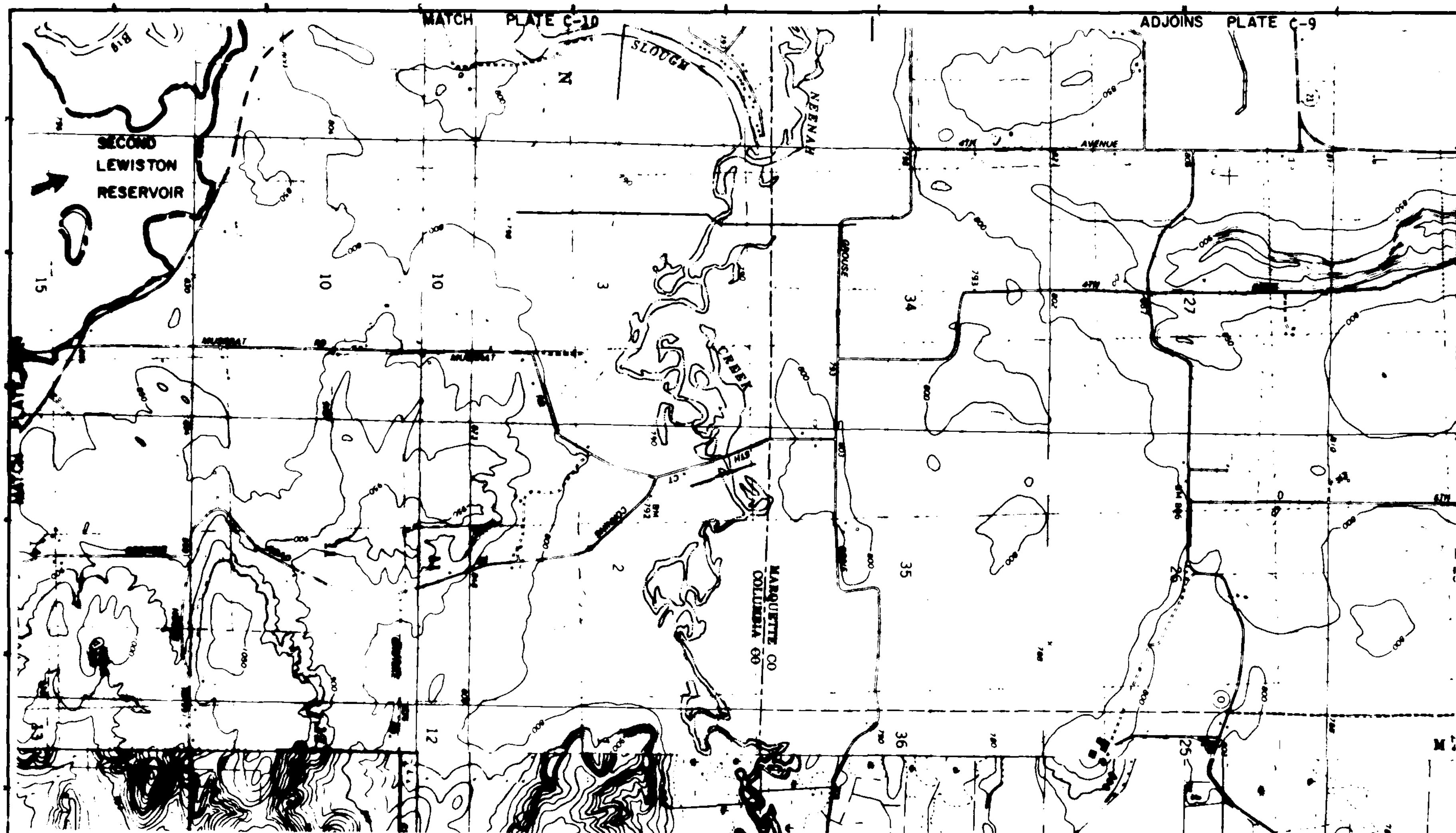
SAFETY PAYS

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

PLATE C-10



GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   LEVEE CONDITION 2 (100 YR.), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR.), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LATERAL RESERVOIRS PEAK STAGES (FT.)

	L.C. 2		L.C. 3	
	100 YR.	SPF	100 YR	SPF
FIRST LEWISTON RES	798	801	*	*
SECOND LEWISTON RES	792	801	792	800
CALEDONIA RES	794	795	*	*
FOX R. SWAMP RES.	778	779	789	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

LEGEND

DIRECTION OF FLOW

(A) CROSS-SECTION

CONDITION 2
(100 YR)
(SPF)

CONDITION 3
(100 YR)
(SPF)

N

SCALE
0 1000 2000 FEET

SAFETY PAYS

DEPARTMENT OF THE ARMY

SUBMITTED BY

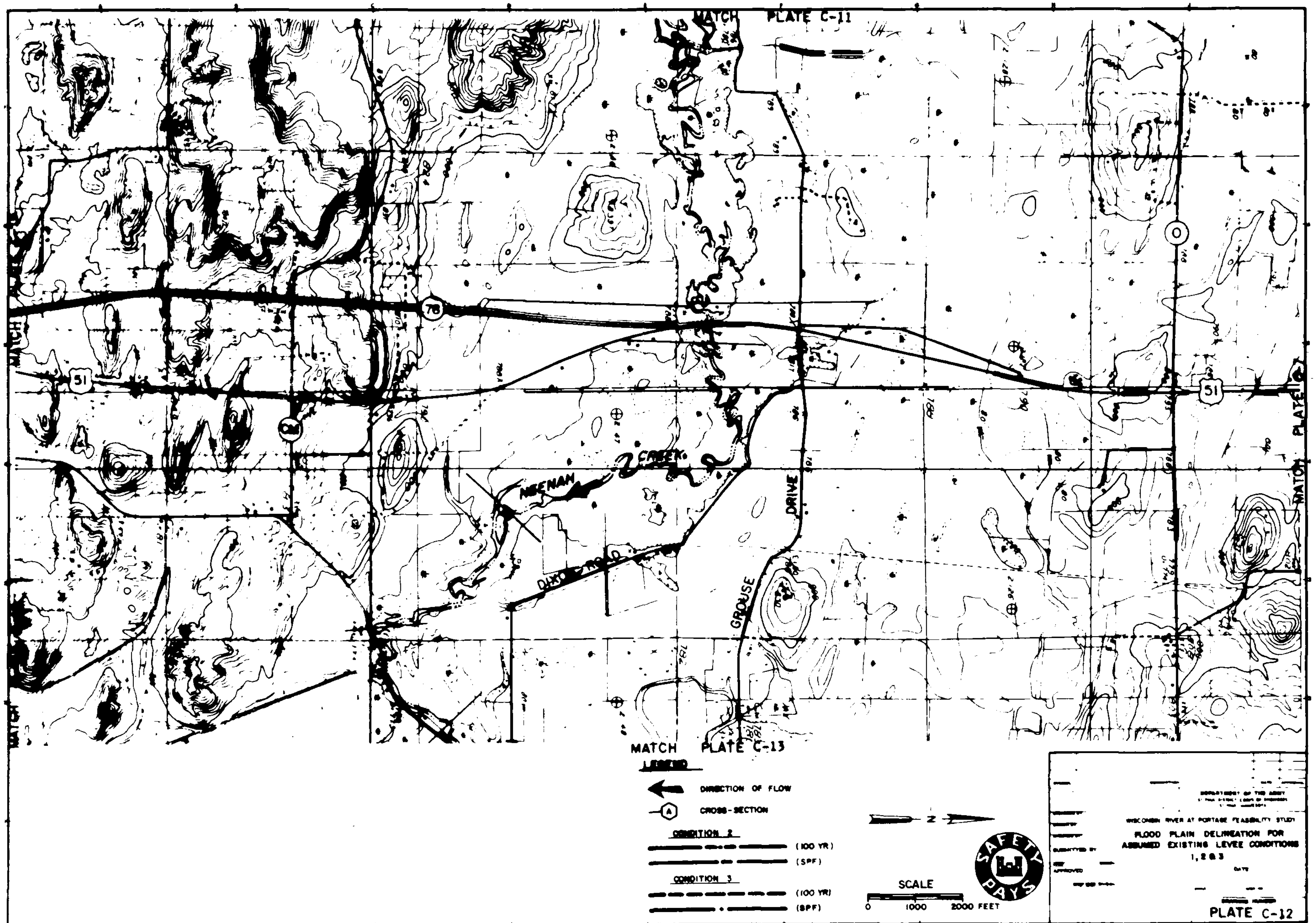
APPROVED

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

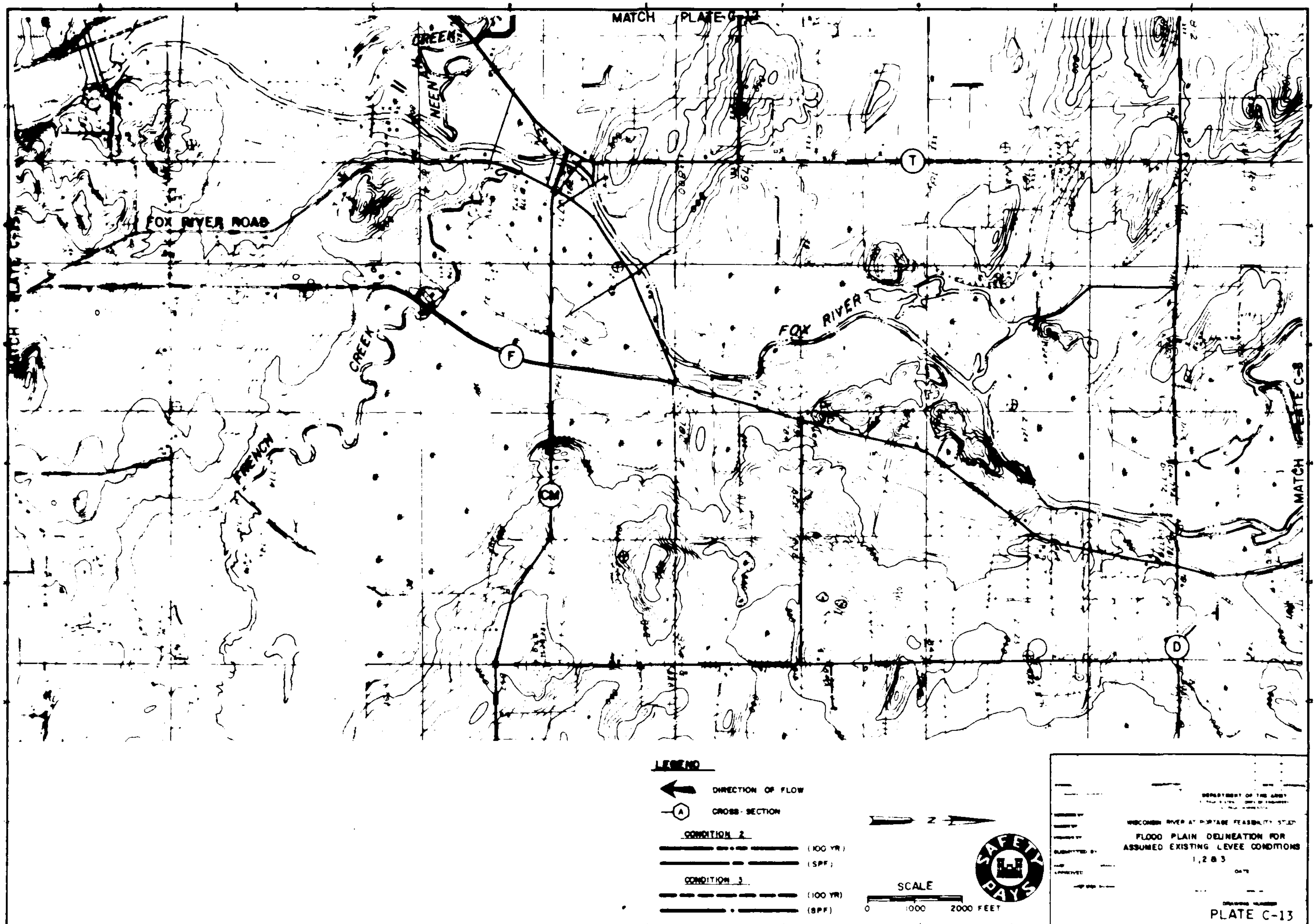
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

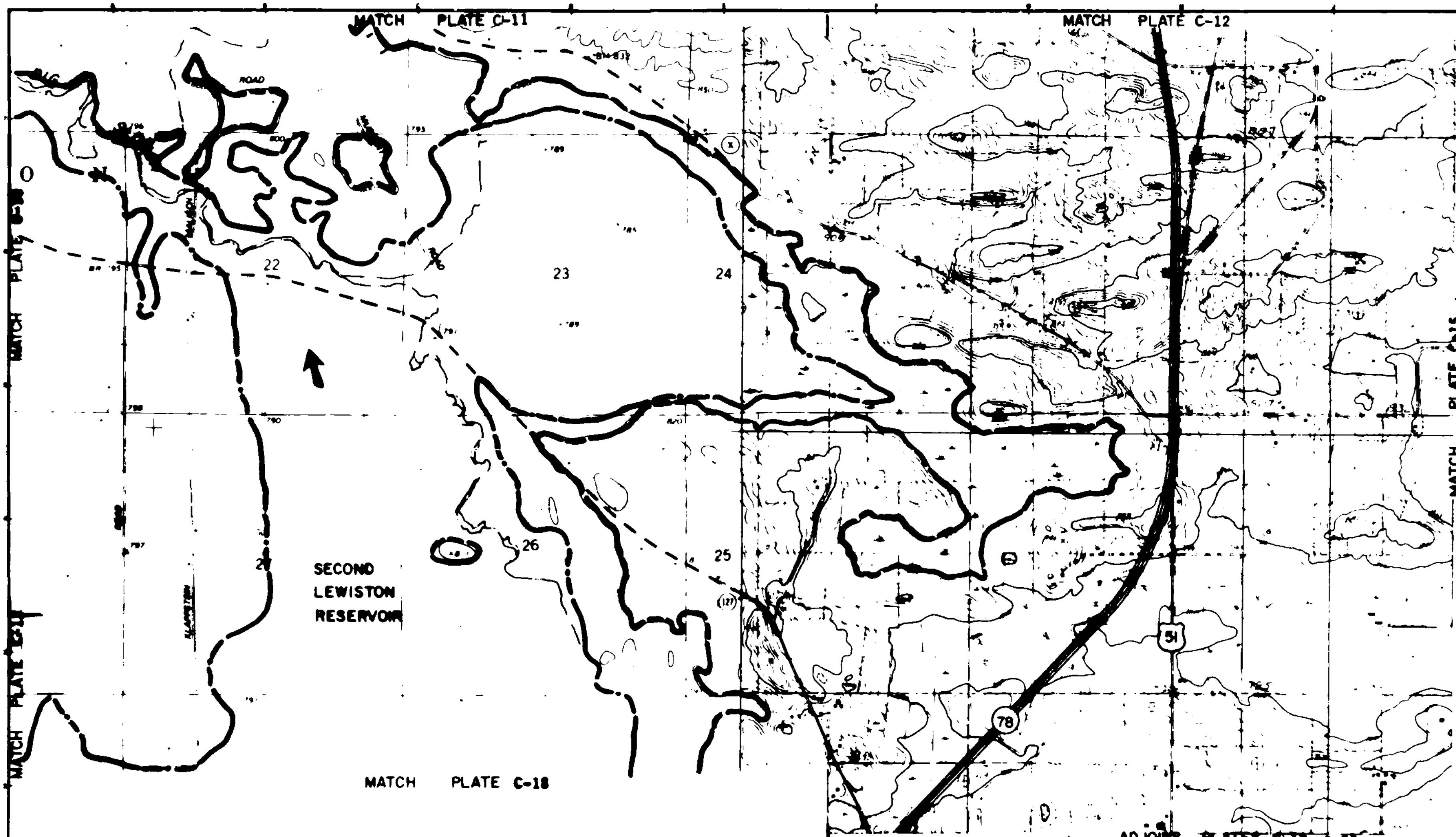
DATE

PLATE C-11



MATCH PLATE C-11
MATCH PLATE C-13
NEENAH CREEK
DRIVE
GROUSE
DIXON ROAD
51
78
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 2
(100 YR)
(SPF)
CONDITION 3
(100 YR)
(SPF)
N
SCALE
0 1000 2000 FEET
SAFETY PAYS
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3
PLATE C-12


MATCH PLATE C-12
FOX RIVER ROAD
FOX RIVER
CREEK
FRENCH
NEEN
GREEN
MATCH PLATE C-8
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 2
(100 YR)
(SPF)
CONDITION 3
(100 YR)
(SPF)
SCALE
0 1000 2000 FEET
SAFETY PAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
1, 2 & 3
PLATE C-13



GENERAL NOTES

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 2 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LATERAL RESERVOIRS PEAK STAGES (FT.)

	L.C. 2		L.C. 3	
	100 YR.	SPF	100 YR	SPF
FIRST LEWISTON RES	796	801	*	*
SECOND LEWISTON RES	792	801	792	800
CALEDONIA RES	794	795	*	*
FOX R. SWAMP RES.	776	779	789	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 2

(100 YR)

(SPF)

CONDITION 3

(100 YR)

(SPF)

N

SCALE

0 1000 2000 FEET

SAFETY PAYS

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

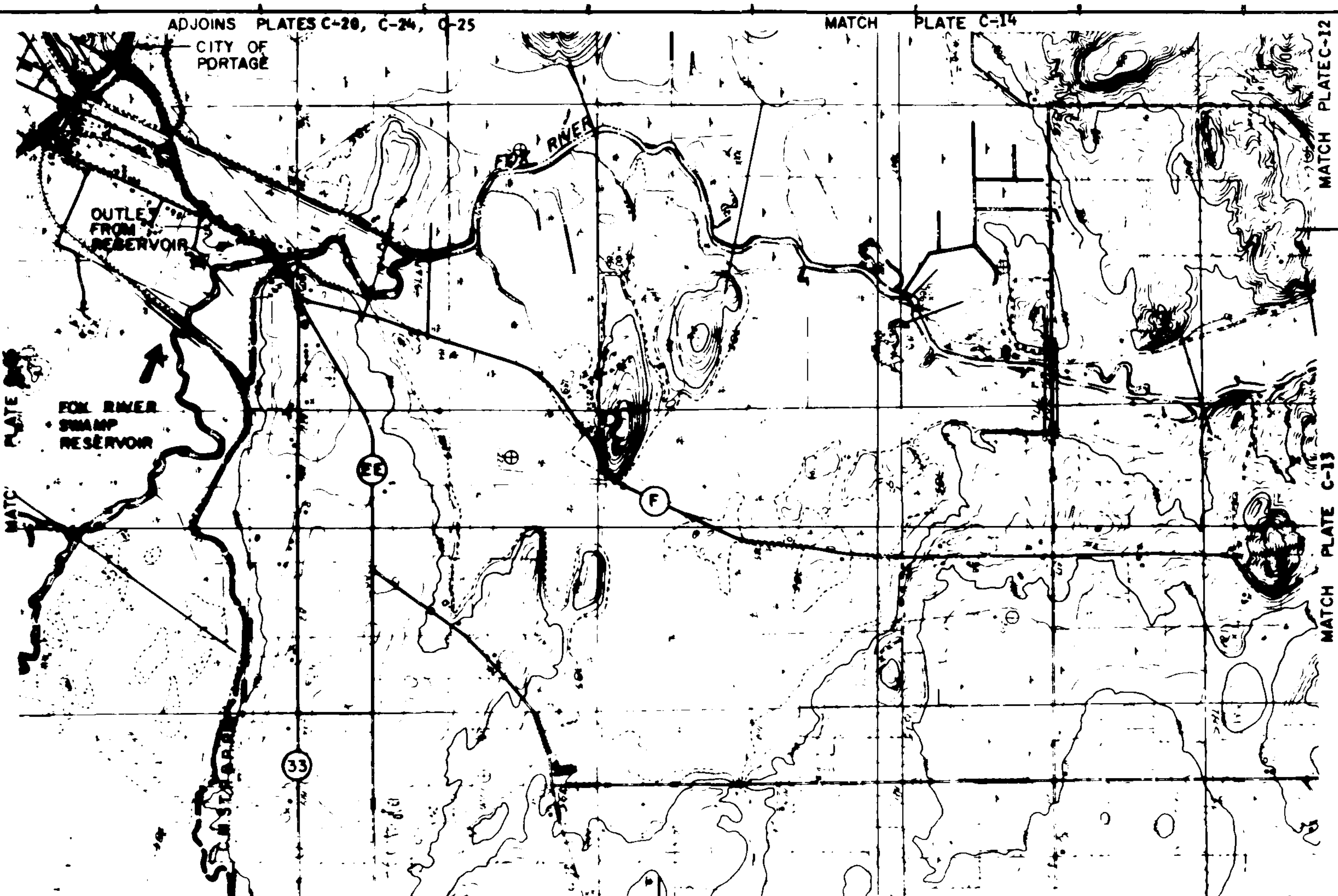
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

SUBMITTED BY

APPROVED

DATE

PLATE C-14



GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 2 (100 YR.), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR.), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LATERAL RESERVOIRS PEAK STAGES (FT.)

	L.C. 2		L.C. 3	
	100 YR.	SPF	100 YR	SPF
FIRST LEWISTON RES	798	801	*	*
SECOND LEWISTON RES	792	801	792	800
CALEDONIA RES	794	795	*	*
FOX R. SWAMP RES.	778	779	789	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

LEGEND

DIRECTION OF FLOW

(A) CROSS-SECTION

CONDITION 2

(100 YR)

(SPF)

CONDITION 3

(100 YR)

(SPF)

N

SCALE

0 1000 2000 FEET

SAFETY PAYS

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

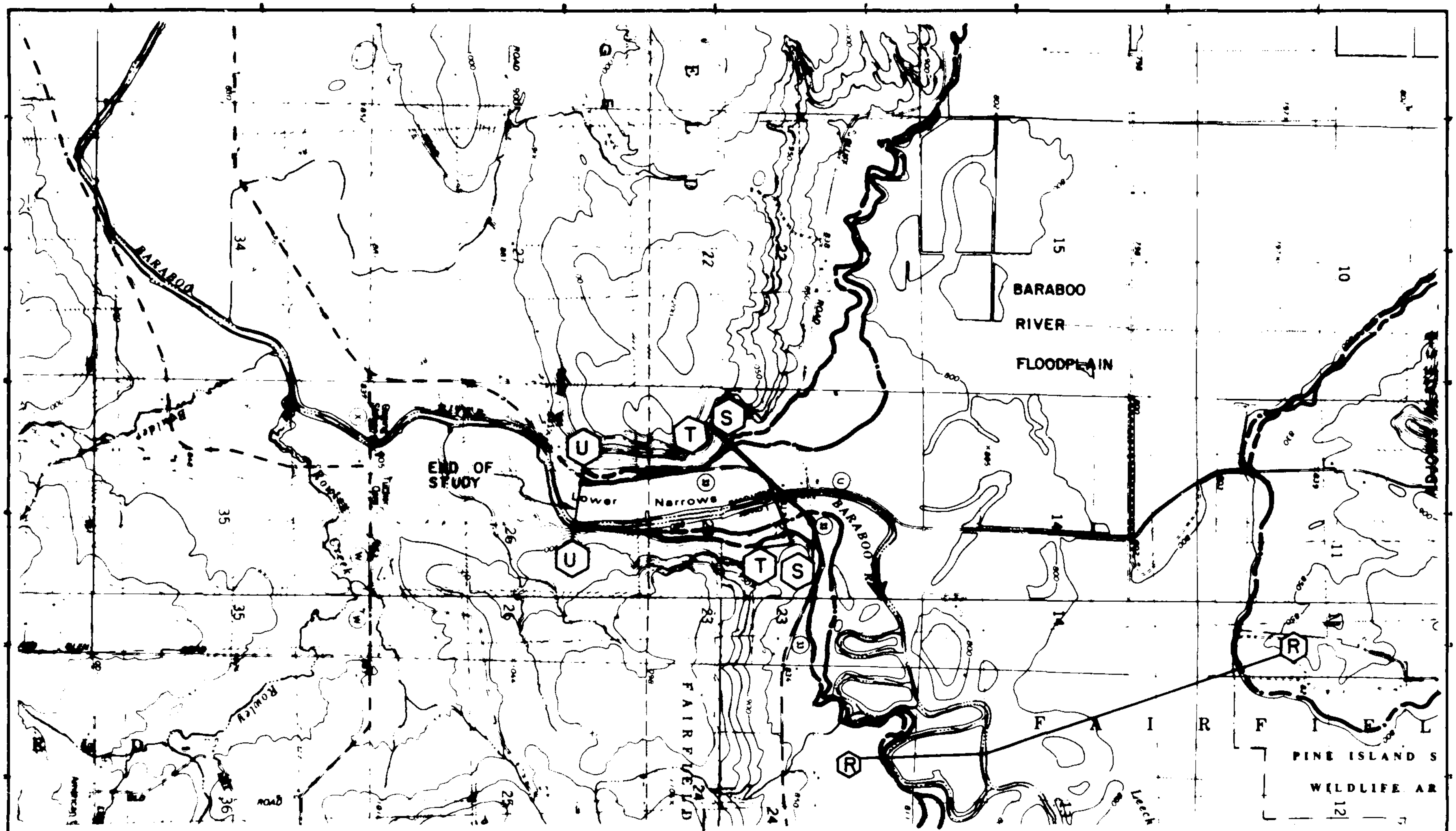
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

SUBMITTED BY

APPROVED

DATE

PLATE C-15



GENERAL NOTES

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 2 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 2

(100 YR)

(SPF)

CONDITION 3

(100 YR)

(SPF)

N

SCALE

0 1000 2000 FEET

SAFETY PAYS

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

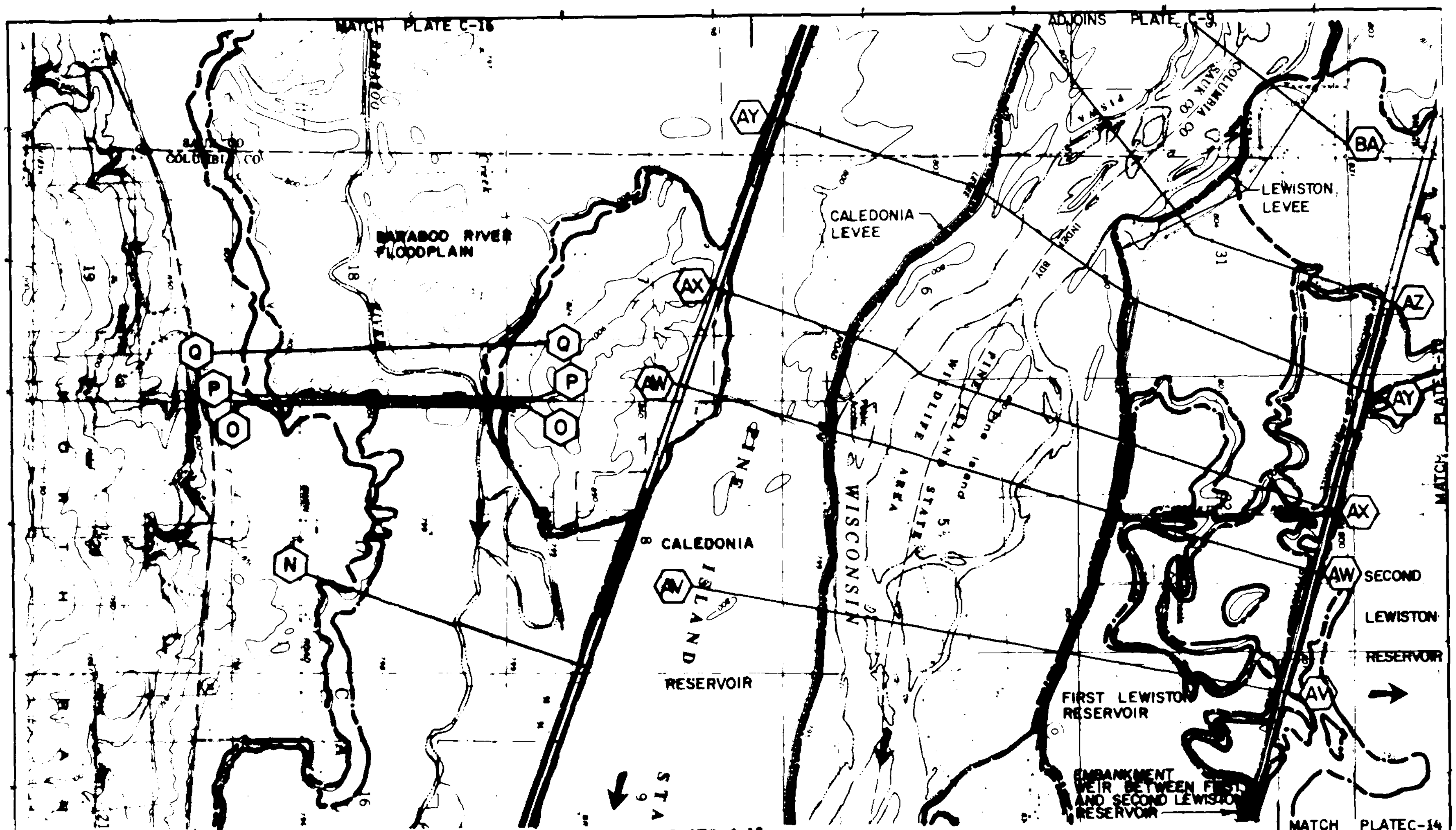
SUBMITTED BY

APPROVED

DATE

DRAWING NUMBER

PLATE C-16



GENERAL NOTES

DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
[illegible] CONDITION 2 (100 YR), THEN (SPF)
[illegible] CONDITION 3 (100 YR), THEN (SPF)
[illegible] CONDITION [illegible] WAS NOT DELINEATED

LATERAL RESERVOIRS PEAK STAGES (FT)

	L.C. 2		L.C. 3	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	798	801	*	*
SECOND LEWISTON RES	792	801	792	800
CALEDONIA RES	794	795	*	*
FOX R. SWAMP RES	778	779	789	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

LEGEND

DIRECTION OF FLOW
CROSS-SECTION
CONDITION 2
(100 YR)
(SPF)
CONDITION 3
(100 YR)
(SPF)

N

SCALE
0 1000 2000 FEET

SAFETY PAYS

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

SUBMITTED BY

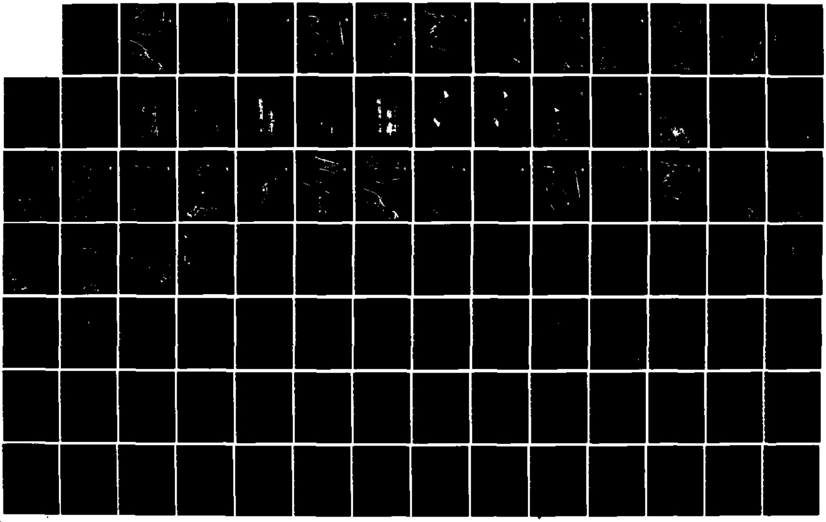
APPROVED

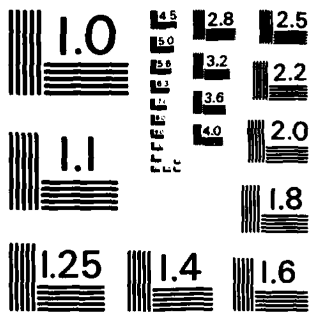
DATE

PLATE C-17

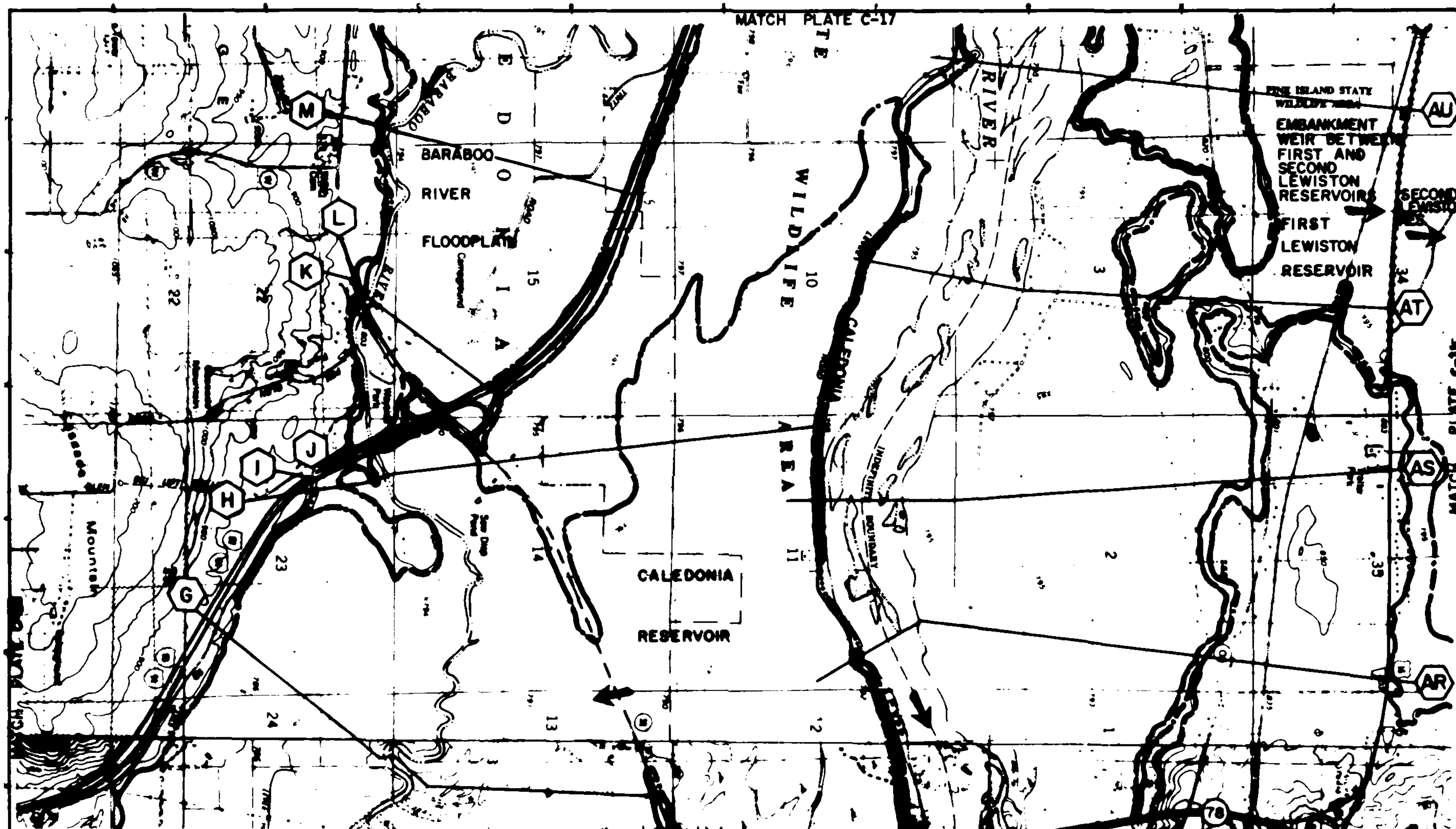
AD-A148 351 FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT WISCONSIN RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 83 4/9

UNCLASSIFIED F/G 13/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



GENERAL NOTES

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 2 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LATERAL RESERVOIRS PEAK STAGES (FT.)

	L.C. 2		L.C. 3	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	796	801	*	*
SECOND LEWISTON RES	792	801	792	800
CALEDONIA RES	794	796	*	*
FOX R. SWAMP RES	776	799	788	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 2

(100 YR)

(SPF)

CONDITION 3

(100 YR)

(SPF)

N

SCALE

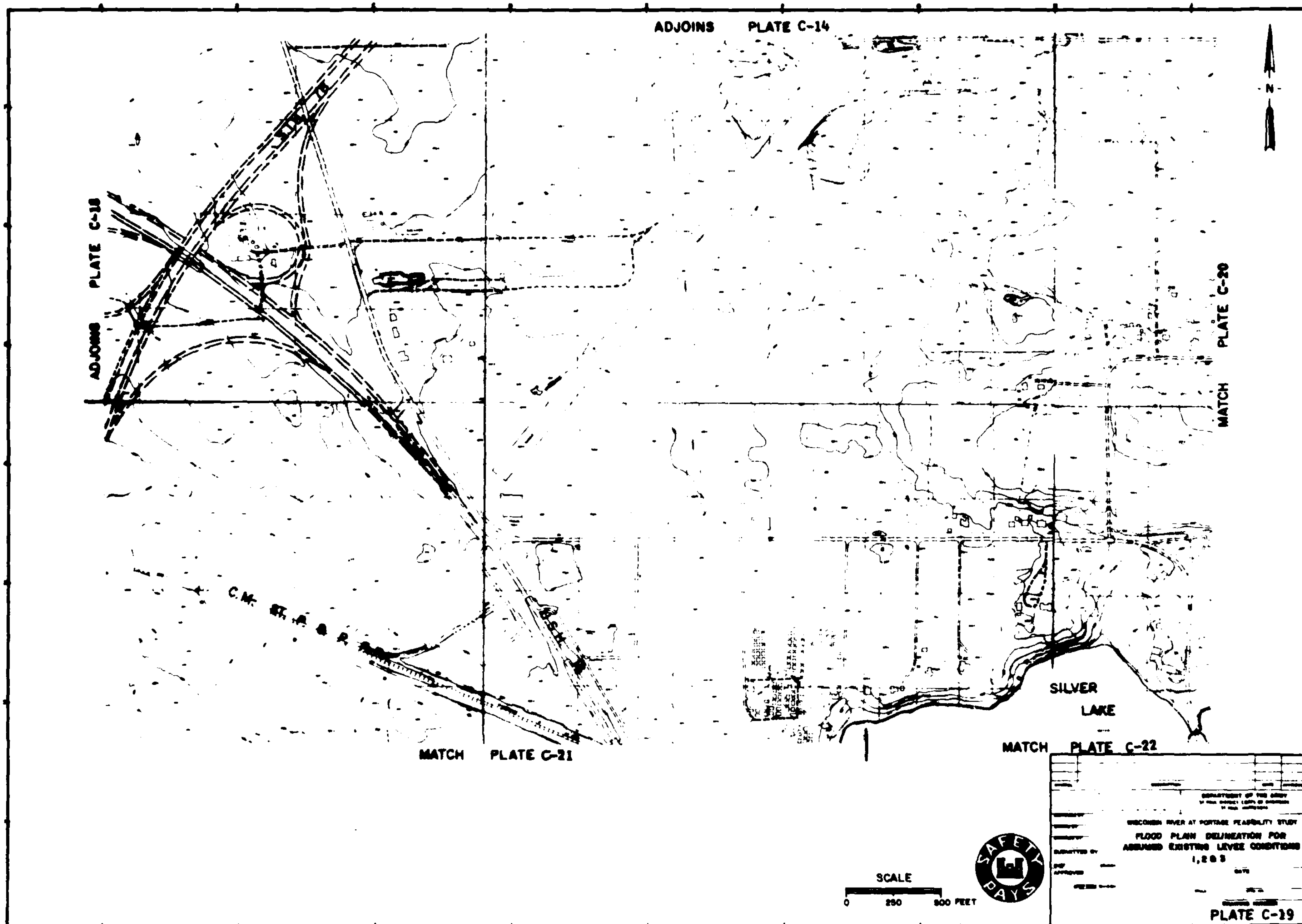
0 1000 2000 FEET

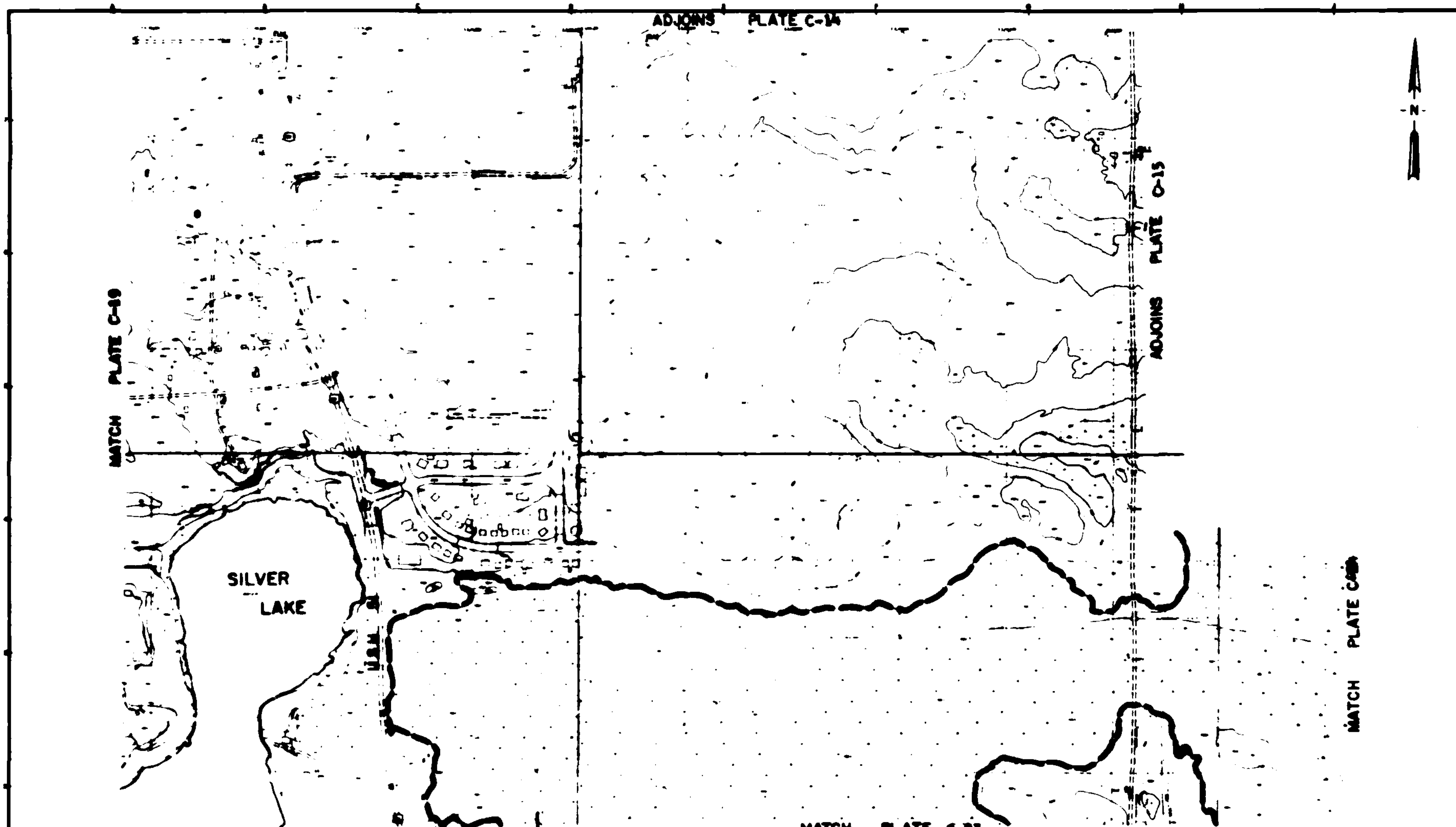
SAFETY PAYS

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

PLATE C-18


ADJOINS PLATE C-14
ADJOINS PLATE C-18
MATCH PLATE C-20
MATCH PLATE C-21
MATCH PLATE C-22
N
C.M. ST. P. & P. R.
SILVER
LAKE
SCALE
0 250 500 FEET
SAFETY PAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
SUBMITTED BY
APPROVED
PLATE C-19



GENERAL NOTES

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 2 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 2

(100 YR)

(SPF)

CONDITION 3

(100 YR)

(SPF)

SCALE

0 250 500 FEET

SAFETY PAYS

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

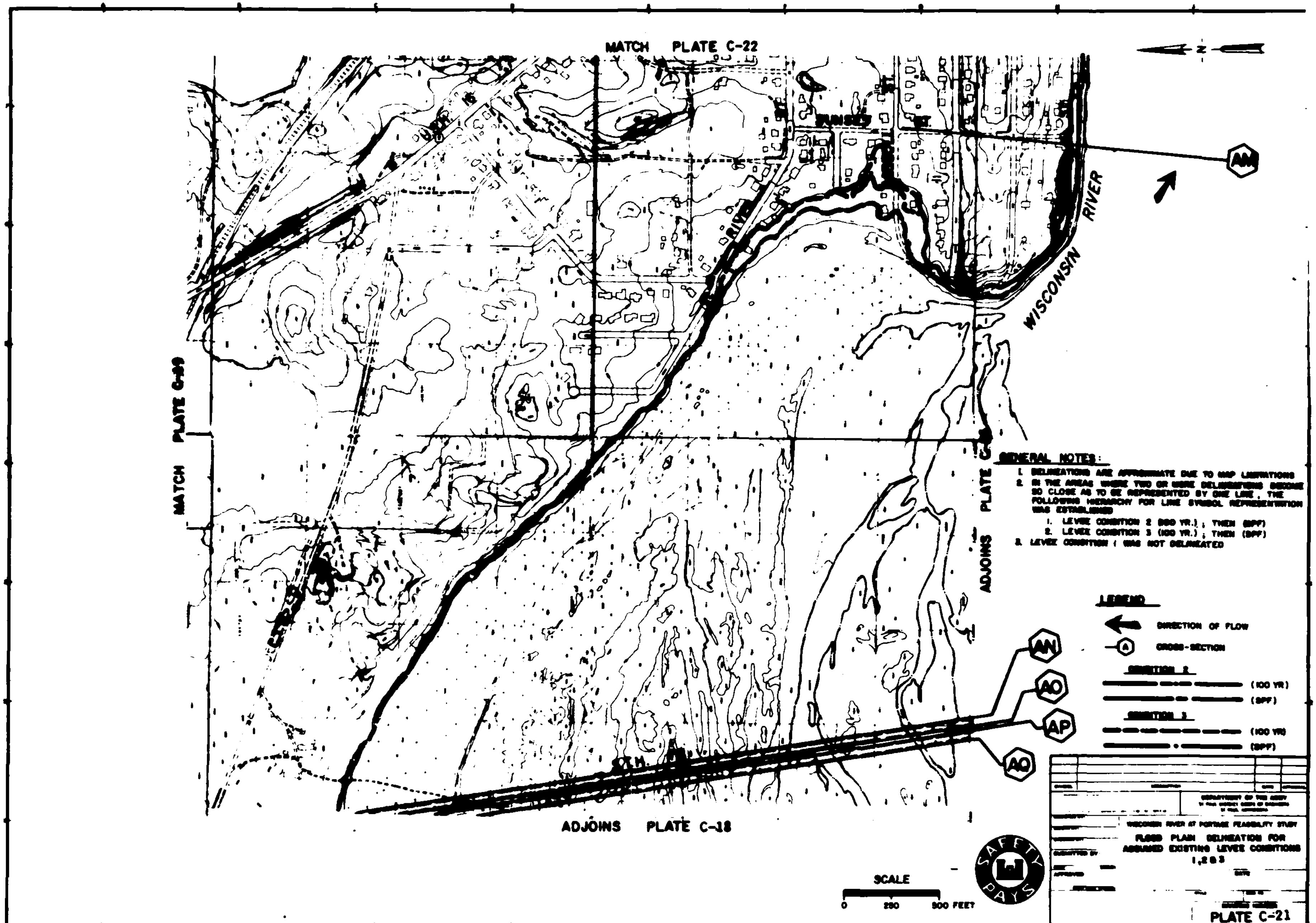
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

SUBMITTED BY

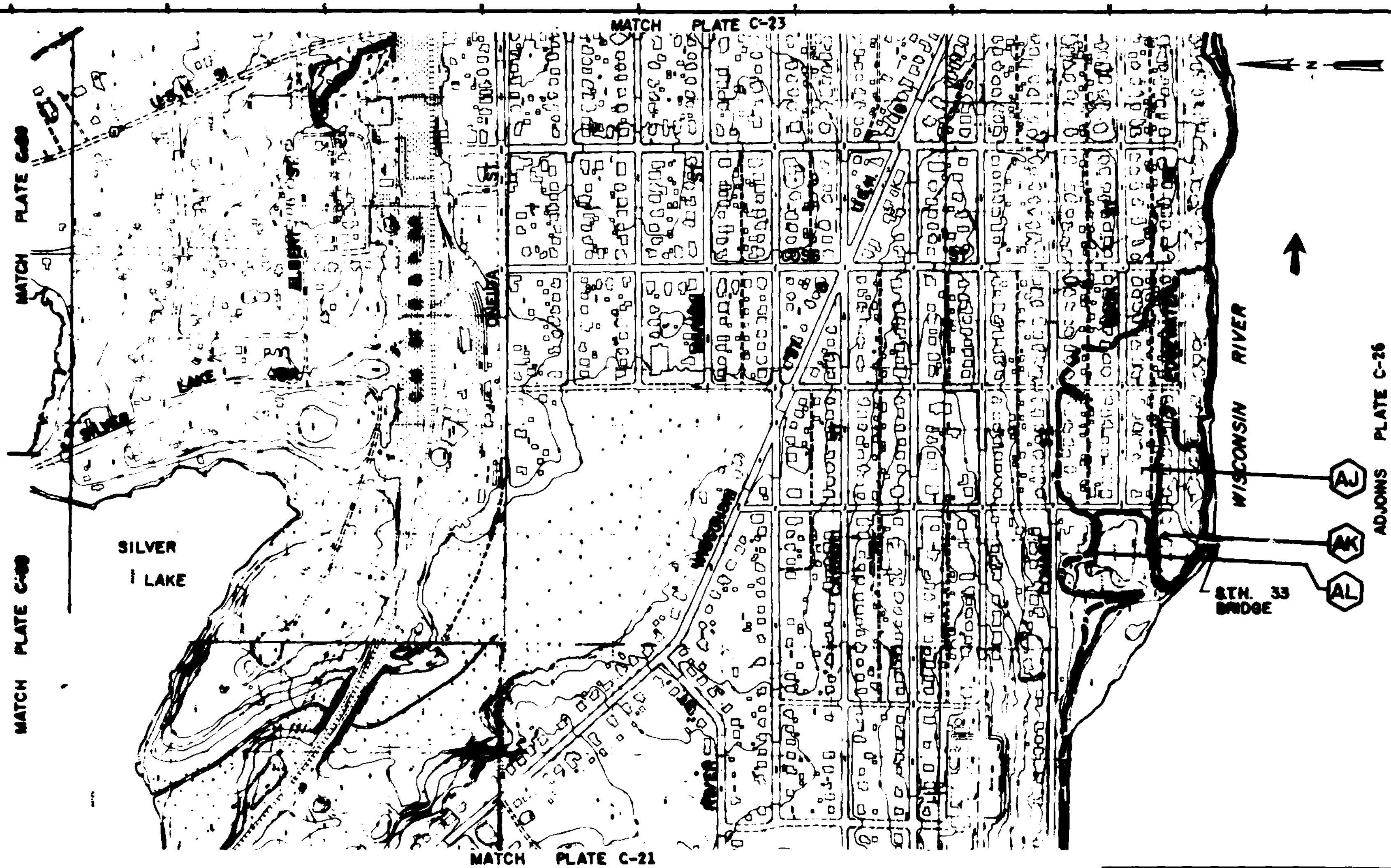
APPROVED

DATE

PLATE C-20



MATCH PLATE C-22
N
AN
WISCONSIN RIVER
MATCH PLATE C-39
ADJOINS PLATE C-18
ADJOINS PLATE C-
GENERAL NOTES:
LEVEE CONDITION 3 (100 YR.) ; THEN (SPF)
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
(100 YR)
(SPF)
AN
AO
AP
AQ
SCALE
0 250 500 FEET
SAFETY PAYS
FLOOD PLAIN DELINEATION FOR
1,2 & 3
PLATE C-21



GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 2 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 2

(100 YR)

(SPF)

CONDITION 3

(100 YR)

(SPF)

SCALE

0 250 500 FEET

SAFETY PAYS

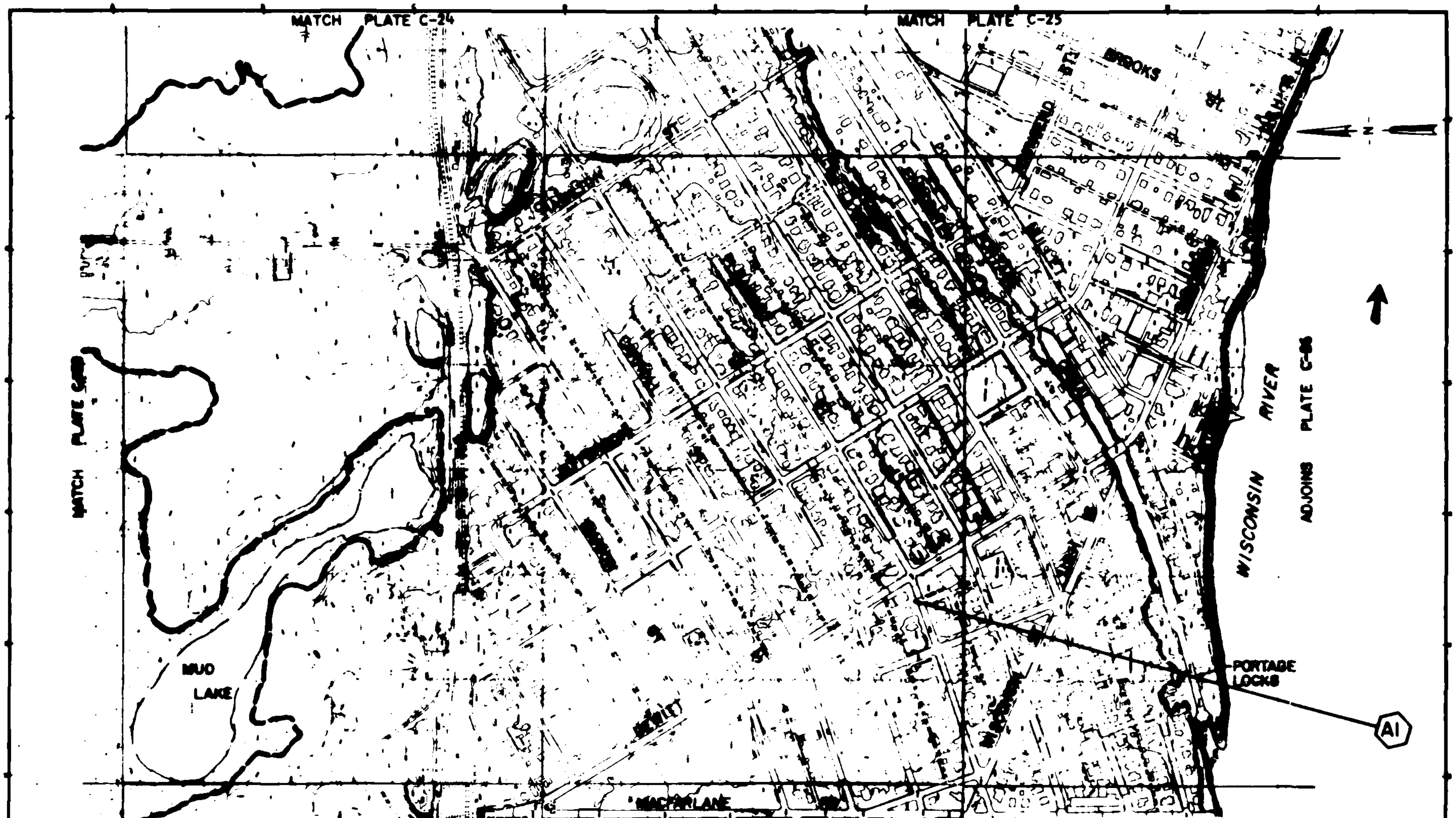
DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS

1,203

PLATE C-22



GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 2 (100 YR.), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR.), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LEGEND

DIRECTION OF FLOW

(A) CROSS-SECTION

CONDITION 2

(100 YR)

(SPF)

CONDITION 3

(100 YR)

(SPF)

SCALE

0 250 500 FEET

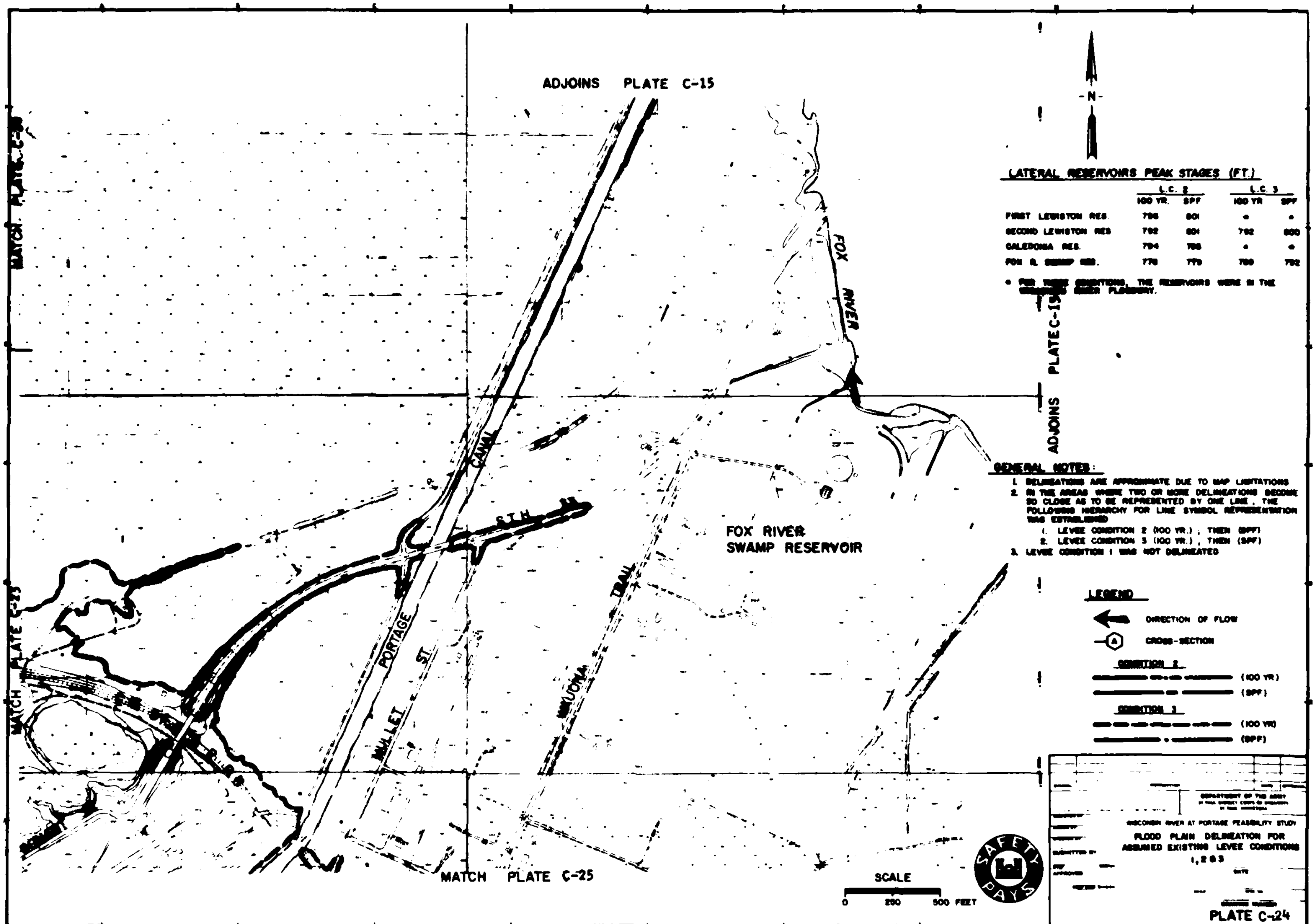
SAFETY PAYS

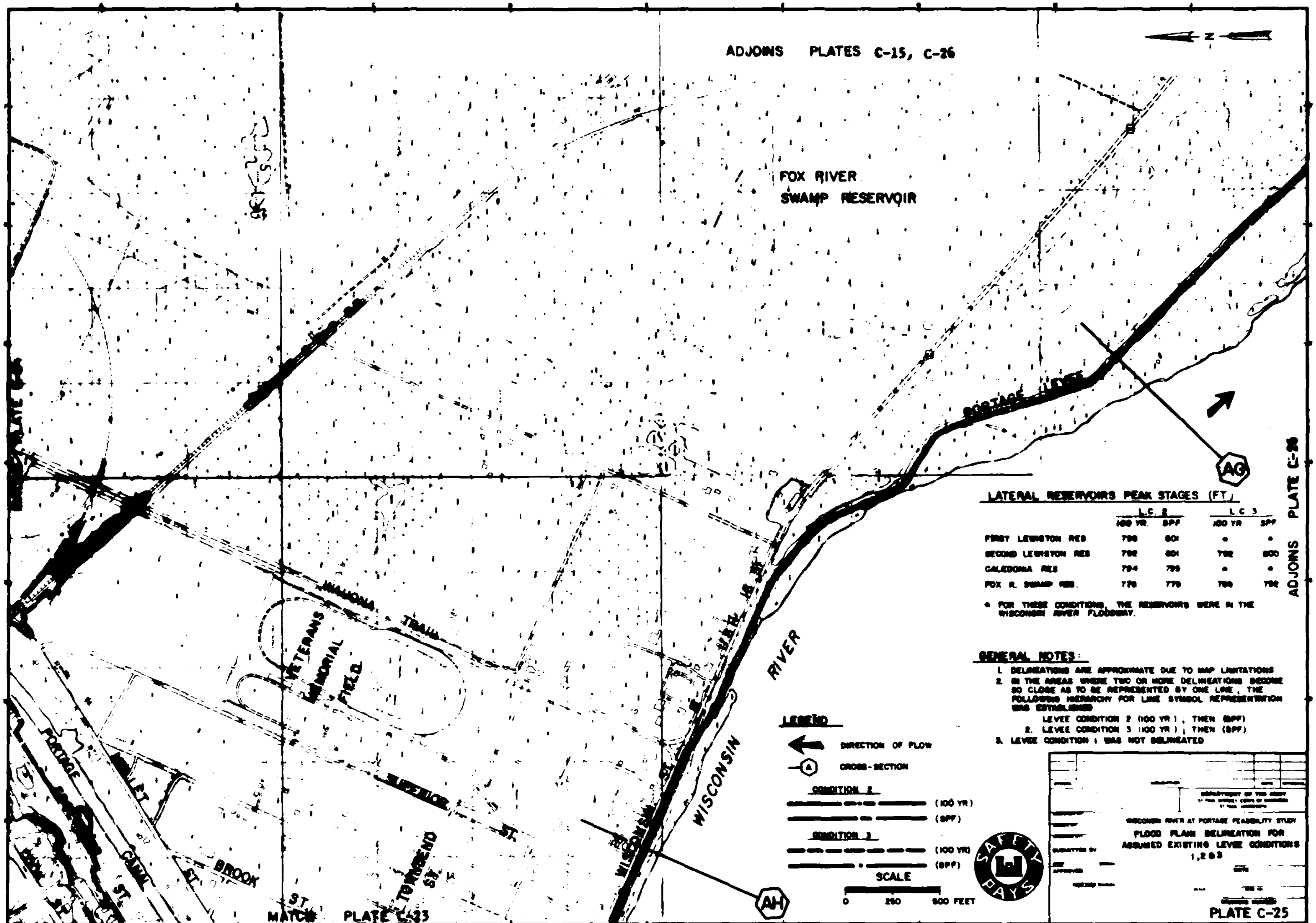
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

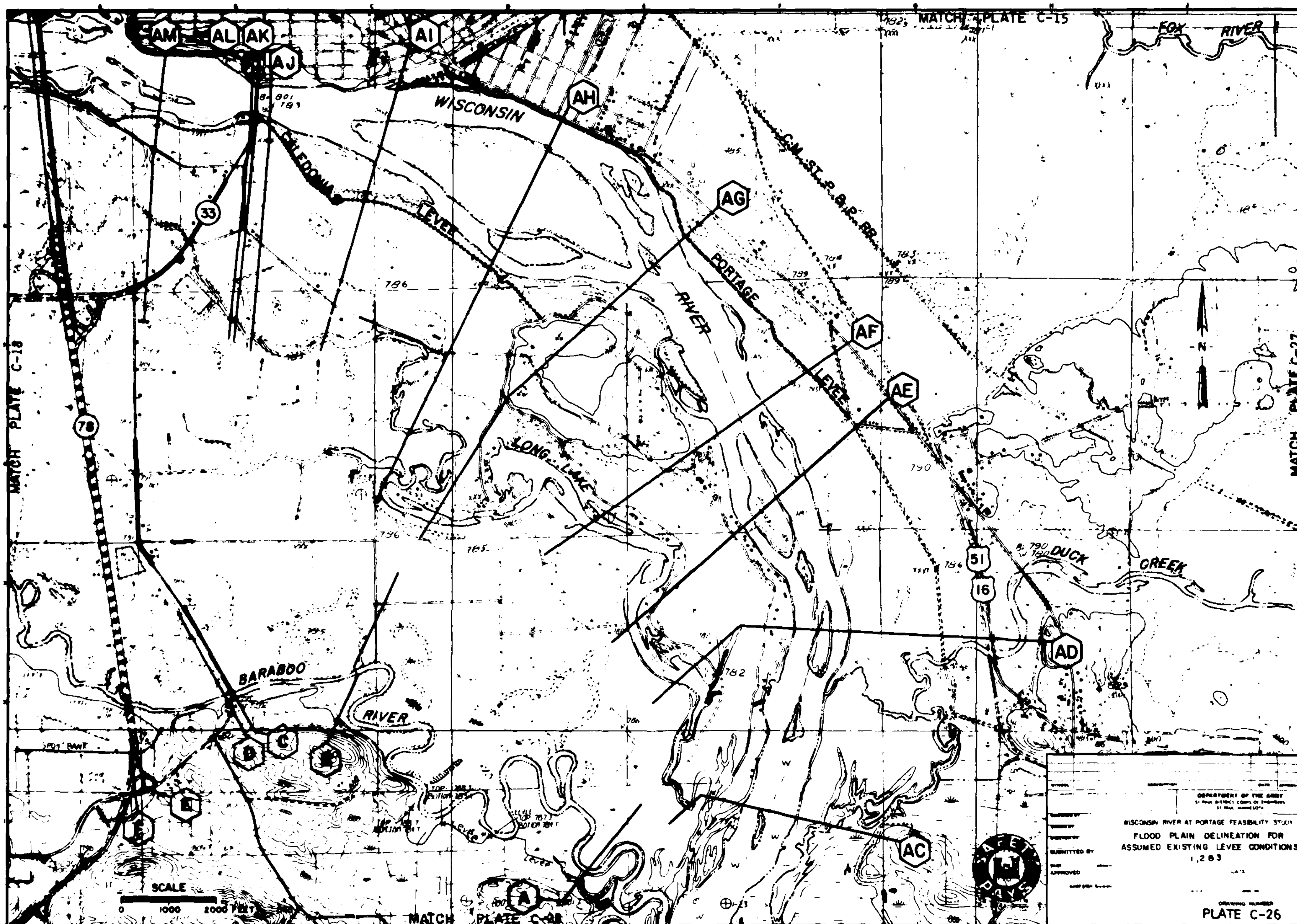
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

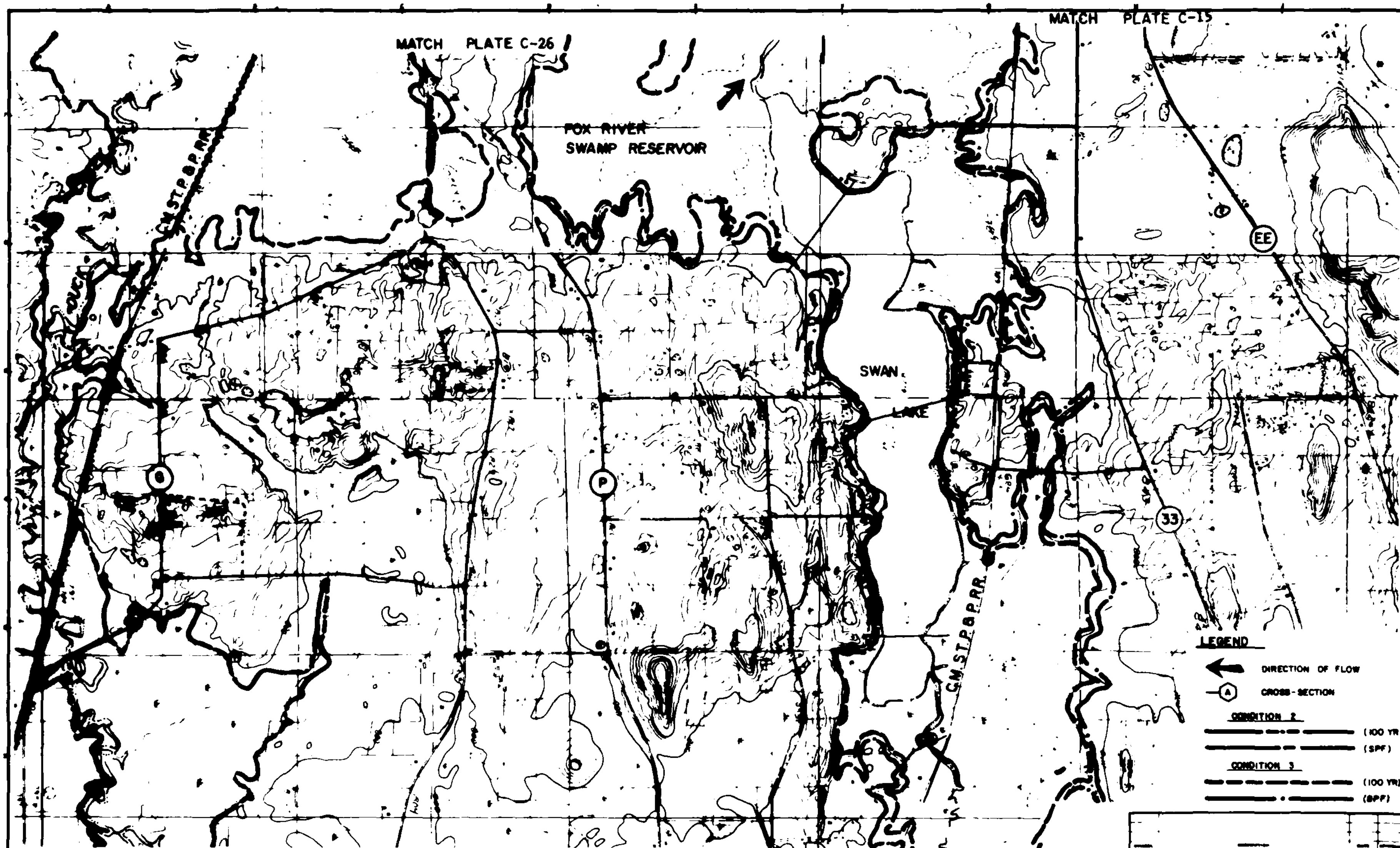
PLATE C-23


ADJOINS PLATE C-15
ADJOINS PLATE C-15
MATCH PLATE C-25
MATCH PLATE C-25
FOX RIVER
FOX RIVER SWAMP RESERVOIR
CANAL
PORTAGE
MULLET ST
TRAIL
STH
N
LATERAL RESERVOIRS PEAK STAGES (FT.)
L.C. 2: 100 YR. SPF
L.C. 3: 100 YR SPF
FIRST LEWISTON RES 796 801 * *
SECOND LEWISTON RES 792 801 792 800
CALEDONIA RES. 794 796 * *
FOX R. SWAMP RES. 778 779 789 792
GENERAL NOTES:
1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
1. LEVEE CONDITION 2 (100 YR.), THEN (SPF)
2. LEVEE CONDITION 3 (100 YR.), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 2
(100 YR)
(SPF)
CONDITION 3
(100 YR)
(SPF)
SCALE
0 250 500 FEET
SAFETY PAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS
1, 2 & 3
PLATE C-24



ADJOINS PLATES C-15, C-26
FOX RIVER
SWAMP RESERVOIR
PORTAGE LEVEE
WISCONSIN RIVER
AG
AH
VETERANS MEMORIAL FIELD
WAUONA TRAIL
SUPERIOR ST.
TOWNSEND ST.
BROOK ST.
CANAL ST.
PORTAGE
ADJOINS PLATE C-36
MATCH PLATE C-23
LATERAL RESERVOIRS PEAK STAGES (FT.)
L.C. 2 — 100 YR. / SPF; L.C. 3 — 100 YR / SPF
FIRST LEWISTON RES 790 801 * *
SECOND LEWISTON RES 792 801 792 800
CALEDONIA RES 794 795 * *
FOX R. SWAMP RES. 778 779 780 782
* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY.
GENERAL NOTES:
1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
LEVEE CONDITION 2 (100 YR); THEN (SPF)
2. LEVEE CONDITION 3 (100 YR); THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 2
(100 YR)
(SPF)
CONDITION 3
(100 YR)
(SPF)
SCALE
0 250 500 FEET
SAFETY PAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS
1,203
PLATE C-25


MATCH PLATE C-15
FOX RIVER
WISCONSIN
C.M. ST. P. & P. RR.
CALEDONIA LEVEE
PORTAGE LEVEE
RIVER
LONG LAKE
DUCK CREEK
BARABOO RIVER
MATCH PLATE C-18
MATCH PLATE C-27
MATCH PLATE C-28
N
AM
AL
AK
AJ
AI
AH
AG
AF
AE
AD
AC
A
B
C
33
78
51
16
SCALE
0 1000 2000 FEET
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
1,283
SUBMITTED BY
APPROVED
DRAWING NUMBER
PLATE C-26



GENERAL NOTES

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 2 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 3 (100 YR), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED

LATERAL RESERVOIRS PEAK STAGES (FT.)

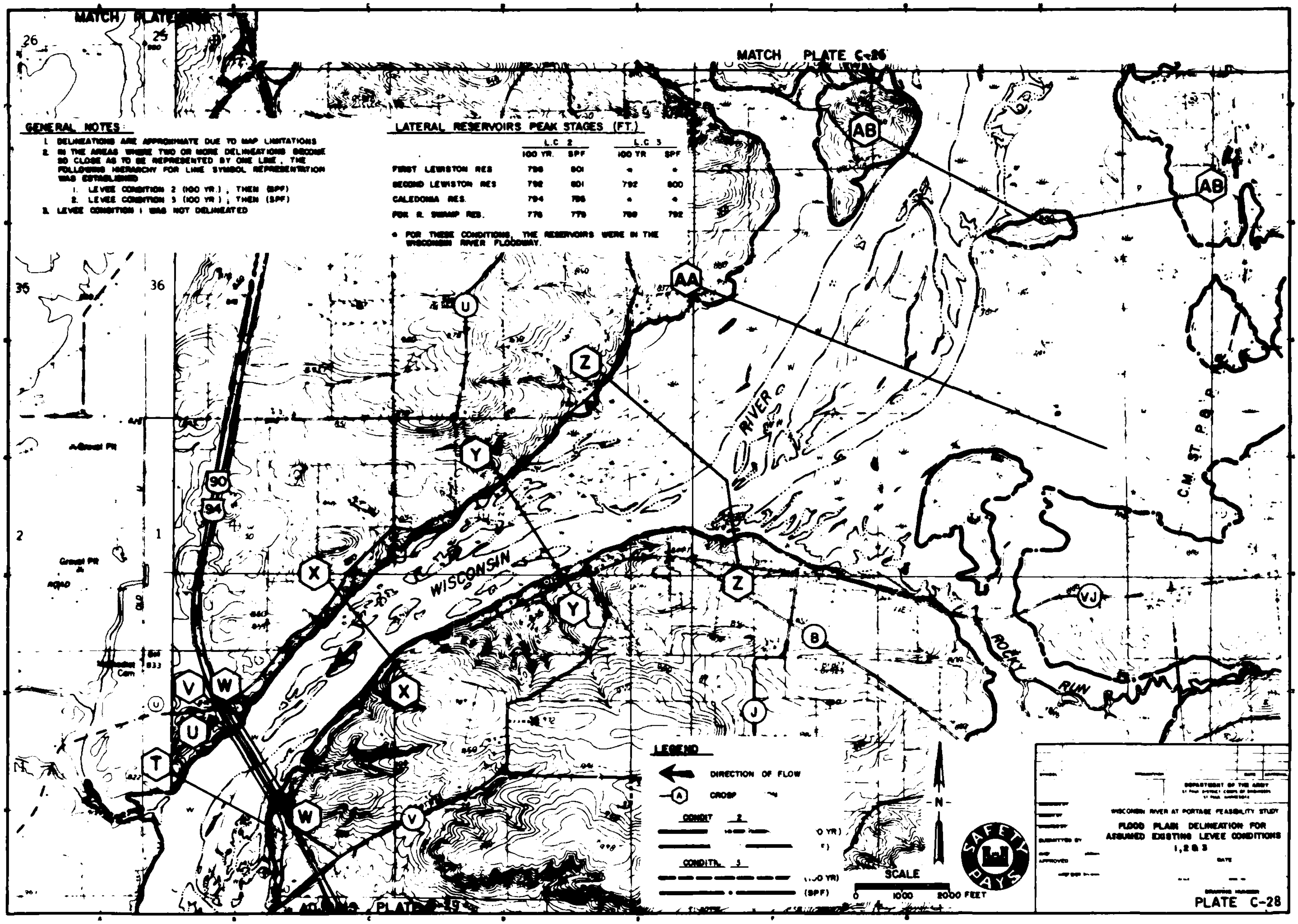
	L.C. 2		L.C. 3	
	100 YR.	SPF	100 YR	SPF
FIRST LEWISTON RES	796	801	*	*
SECOND LEWISTON RES	792	801	792	800
CALEDONIA RES	794	795	*	*
FOX R. SWAMP RES	778	779	789	792

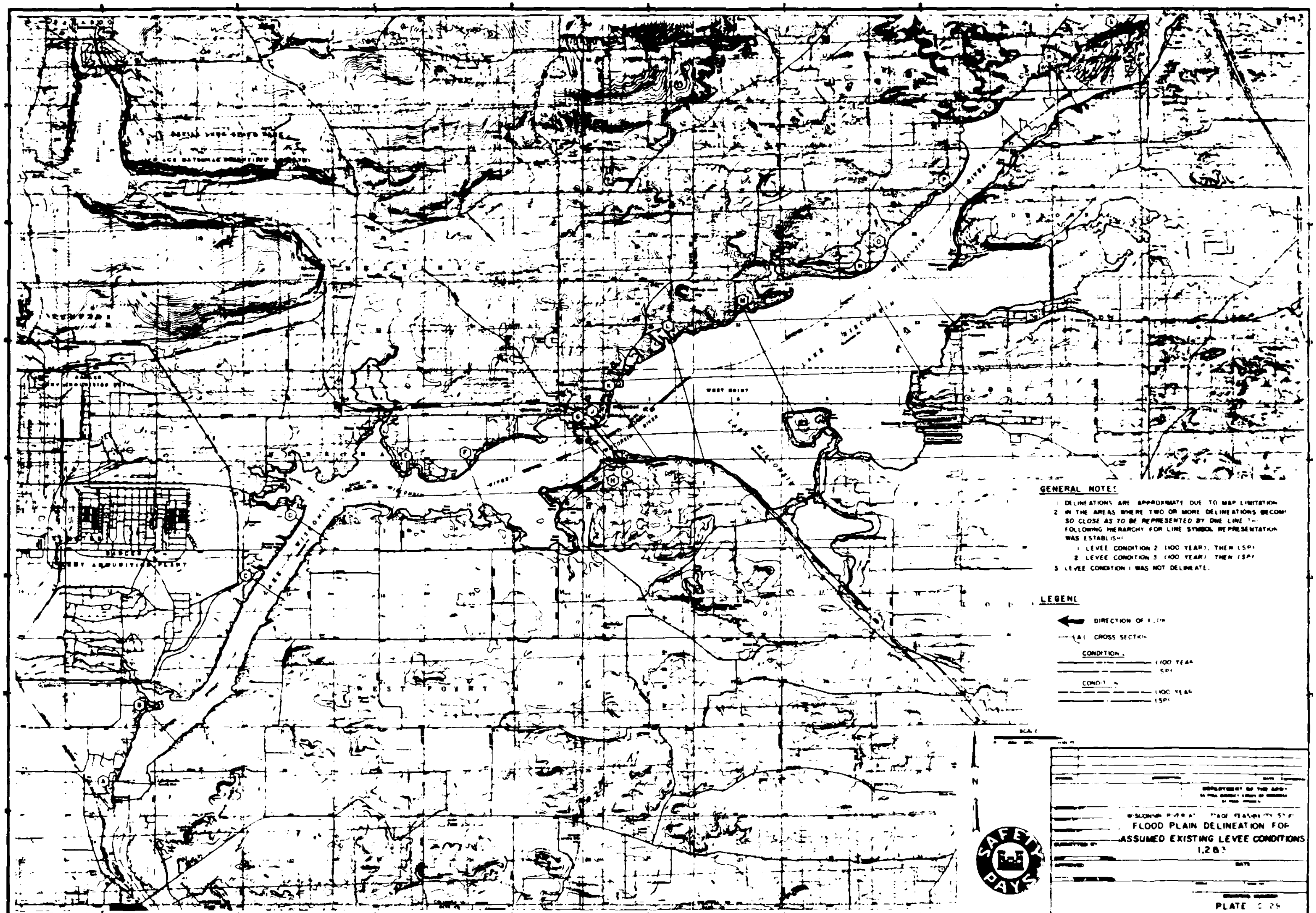
* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY.

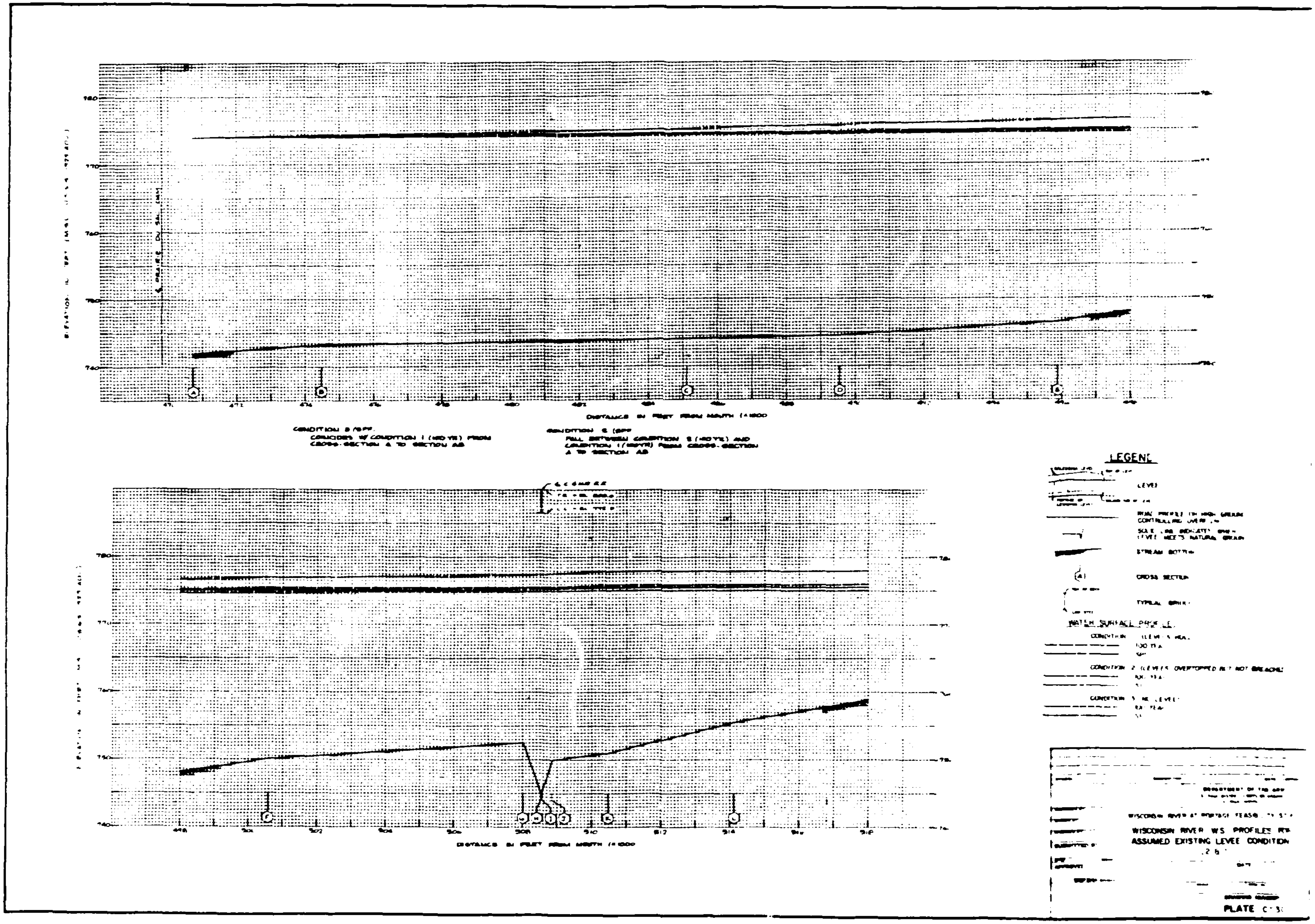
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

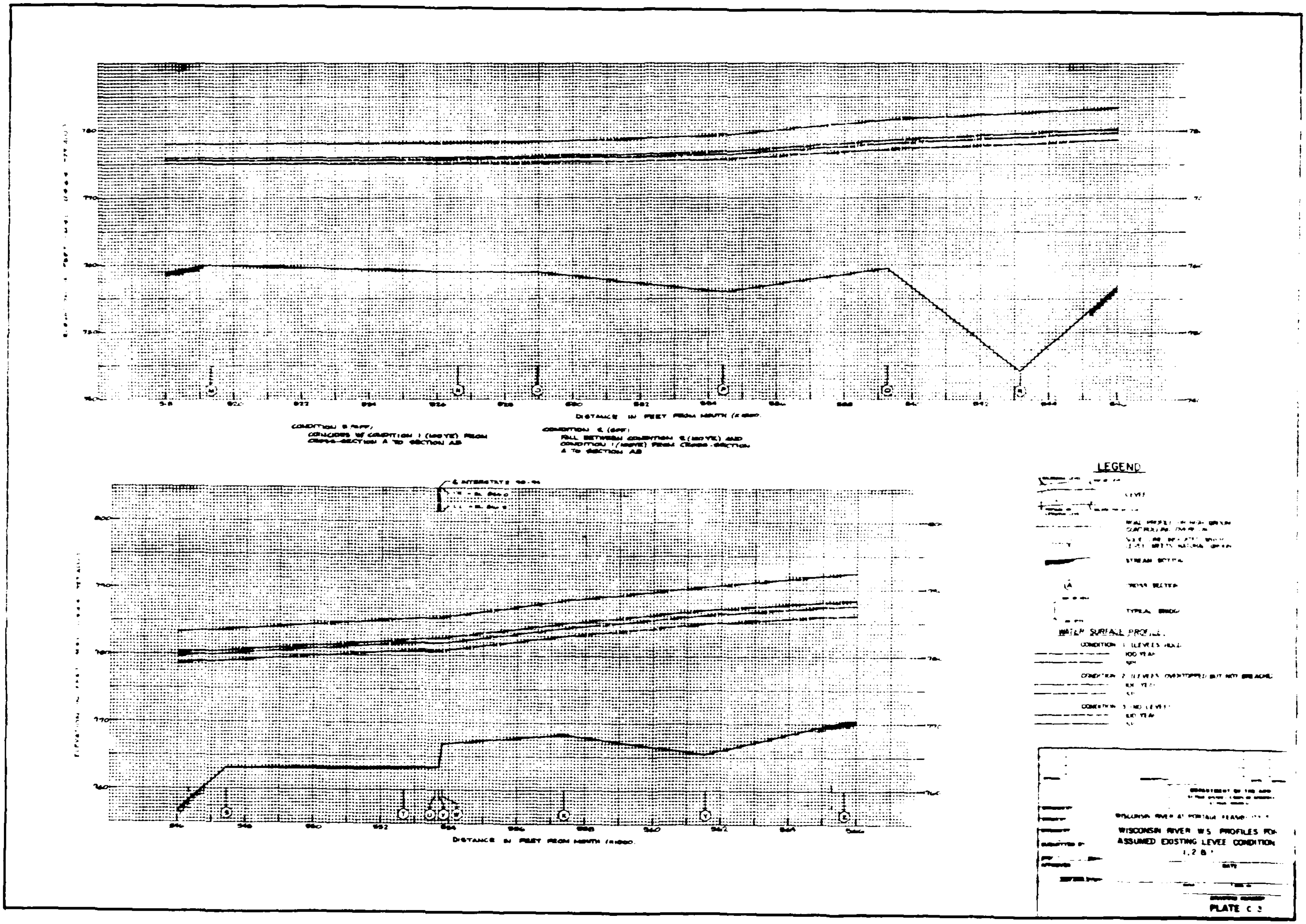
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1,2 & 3

PLATE C-27

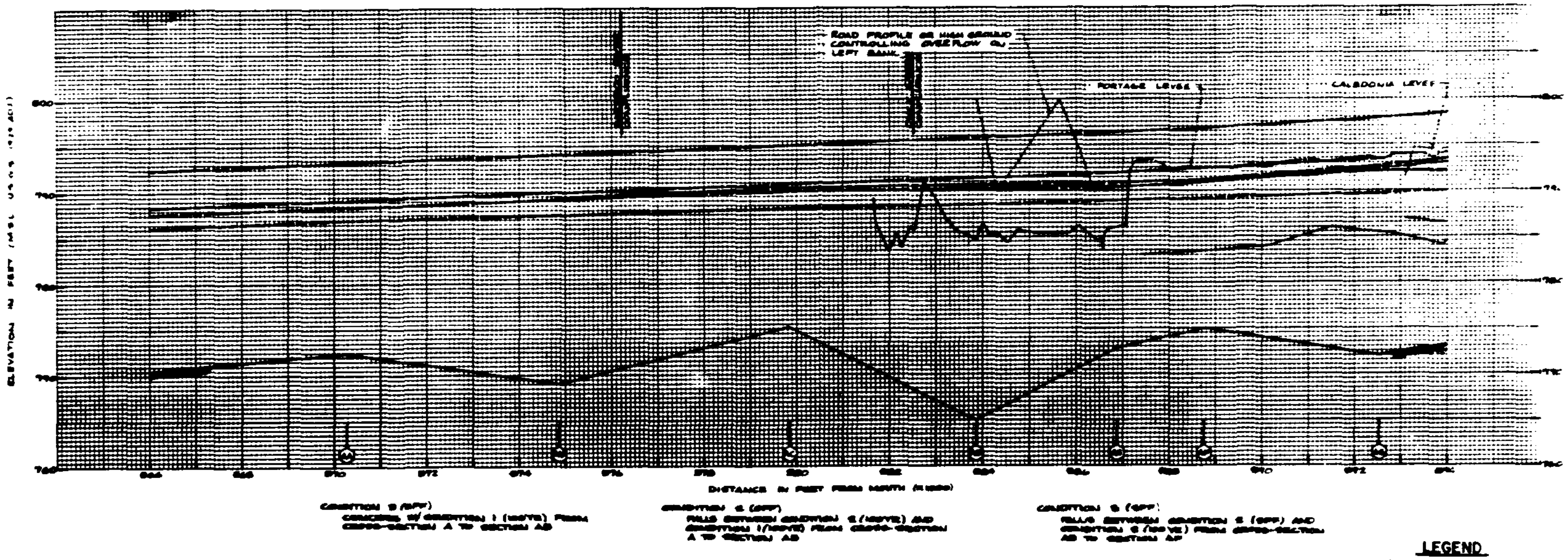

MATCH PLATE C-26
MATCH PLATE
GENERAL NOTES:
1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
1. LEVEE CONDITION 2 (100 YR.), THEN (SPF)
2. LEVEE CONDITION 3 (100 YR.), THEN (SPF)
3. LEVEE CONDITION 1 WAS NOT DELINEATED
LATERAL RESERVOIRS PEAK STAGES (FT.)
L.C 2 100 YR. SPF — L.C 3 100 YR SPF
FIRST LEWISTON RES 796 801 * *
SECOND LEWISTON RES 792 801 792 800
CALEDONIA RES. 794 796 * *
FOX R. SWAMP RES. 778 779 780 792
* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY.
WISCONSIN
RIVER
ROCKY RUN
C.M. ST. P. & P.
90
94
AB
AA
Z
Y
X
W
V
U
T
B
J
VJ
26
25
36
1
2
LEGEND
DIRECTION OF FLOW
CROSS
CONDIT. 2
(100 YR)
CONDIT. 3
(100 YR)
(SPF)
N
SCALE
0 1000 2000 FEET
SAFETY PAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3
SUBMITTED BY
APPROVED
DATE
PLATE C-28

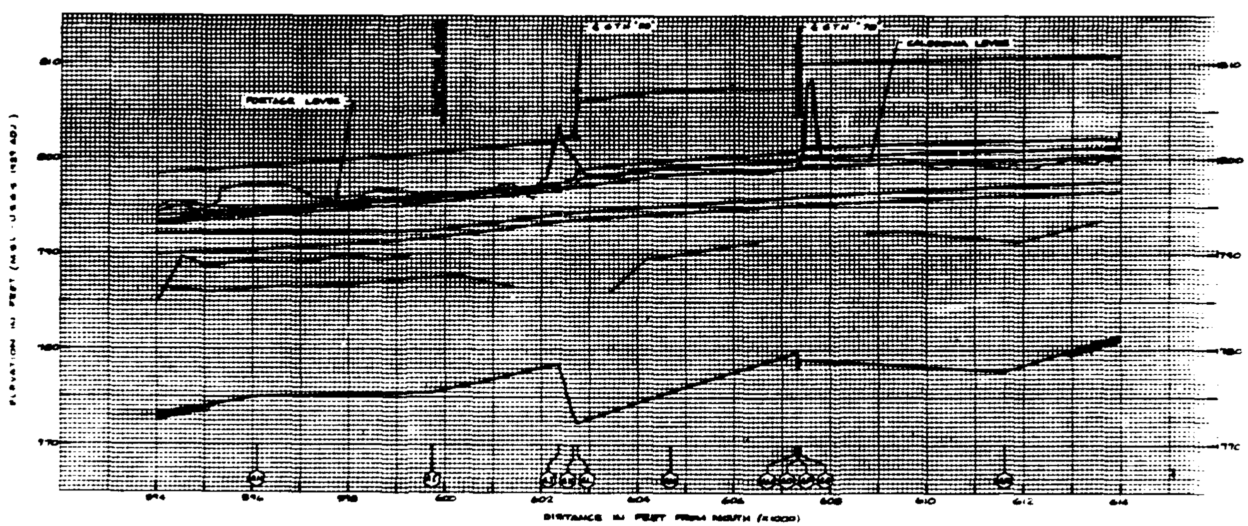

GENERAL NOTES
1 DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATION
2 IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOM SO CLOSE AS TO BE REPRESENTED BY ONE LINE THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISH
1 LEVEE CONDITION 2 (100 YEAR), THEN (SPF
2 LEVEE CONDITION 3 (100 YEAR) THEN (SPF
3 LEVEE CONDITION 1 WAS NOT DELINEATE.
LEGEND
DIRECTION OF FLOW
CROSS SECTION
CONDITION
100 YEAR
SPF
CONDITION
100 YEAR
SPF
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
SAFETY PAYS
PLATE


CONDITION 3 (SPF)
COINCIDES W/ CONDITION 1 (100 YR) FROM CROSS-SECTION A TO SECTION AB
CONDITION 5 (SPF)
FALL BETWEEN CONDITION 2 (100 YR) AND CONDITION 1 (100 YR) FROM CROSS-SECTION A TO SECTION AB
DISTANCE IN FEET FROM MOUTH (×1000)
LEGEND
LEVEE
ROAD PROFILE OR HIGH GROUND CONTROLLING OVERFLOW
SOLE LINE INDICATES WHEN LEVEE MEETS NATURAL GROUND
STREAM BOTTOM
CROSS SECTION
TYPICAL BRIDGE
WATER SURFACE PROFILE
CONDITION 2 (LEVEES OVERTOPPED BUT NOT BREACHED)
WISCONSIN RIVER W.S. PROFILES
ASSUMED EXISTING LEVEE CONDITION
PLATE C-3



DISTANCE IN FEET FROM MOUTH
LEGEND
STREAM BOTTOM
TYPICAL BRIDGE
WATER SURFACE PROFILES
100 YEAR
WISCONSIN RIVER W.S. PROFILES FOR
ASSUMED EXISTING LEVEE CONDITION
PLATE C 3





LEGEND

LEVEES

ROAD PROFILE OR HIGH GROUND CONTROLLING OVERFLOW

SOLID LINE INDICATES WHERE LEVEE MEETS NATURAL GROUND

STREAM BOTTOM

CROSS-SECTION

TYPICAL BRIDGE

WATER SURFACE PROFILES

CONDITION 1 (LEVEES HOLD)
100 YEAR
SPF

CONDITION 2 (LEVEES OVERTOPPED BUT NOT BREACHED)
100 YEAR
SPF

CONDITION 3 (NO LEVEES)
100 YEAR
SPF

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

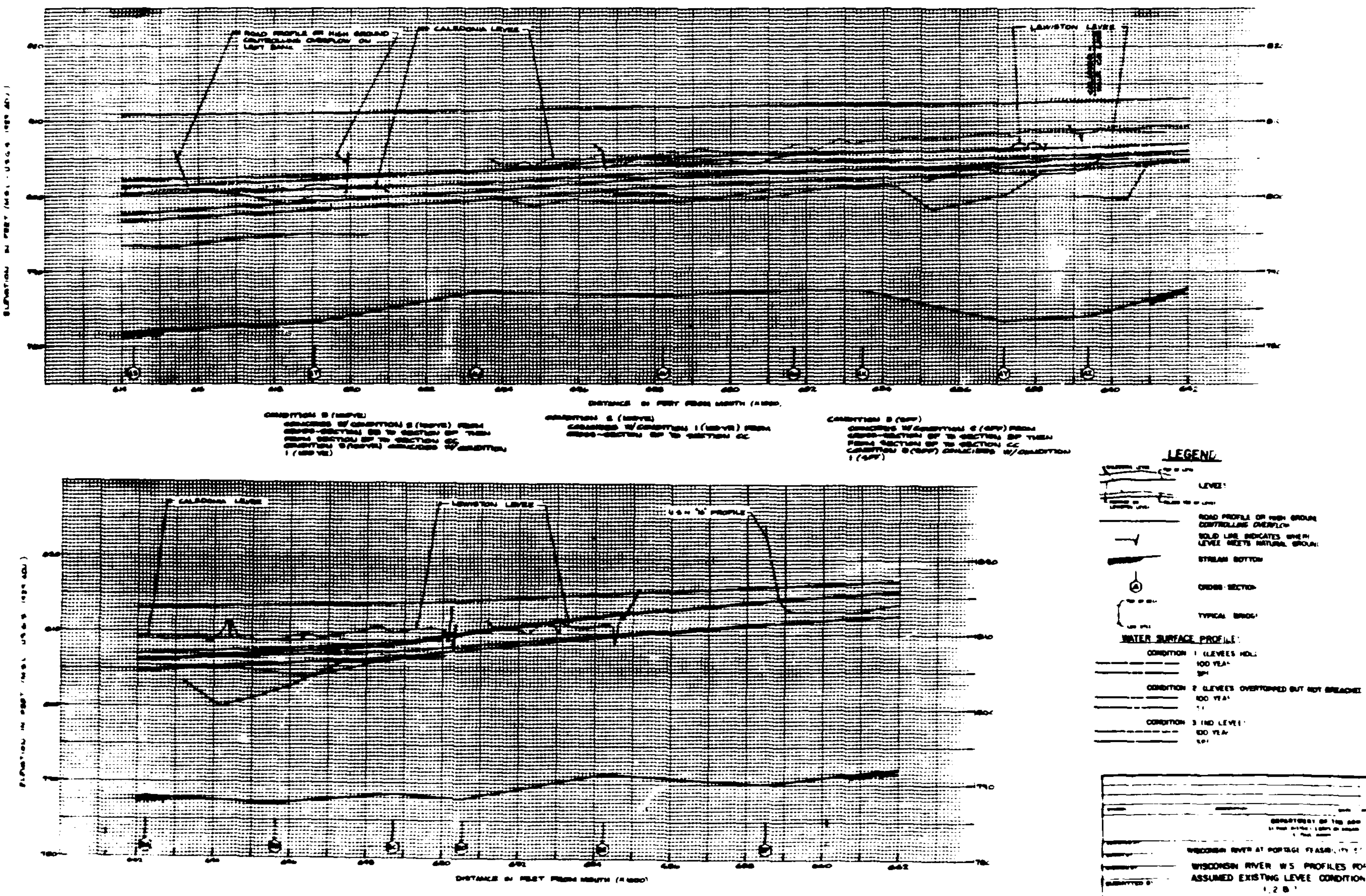
WISCONSIN RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

SUBMITTED BY

APPROVED

DATE

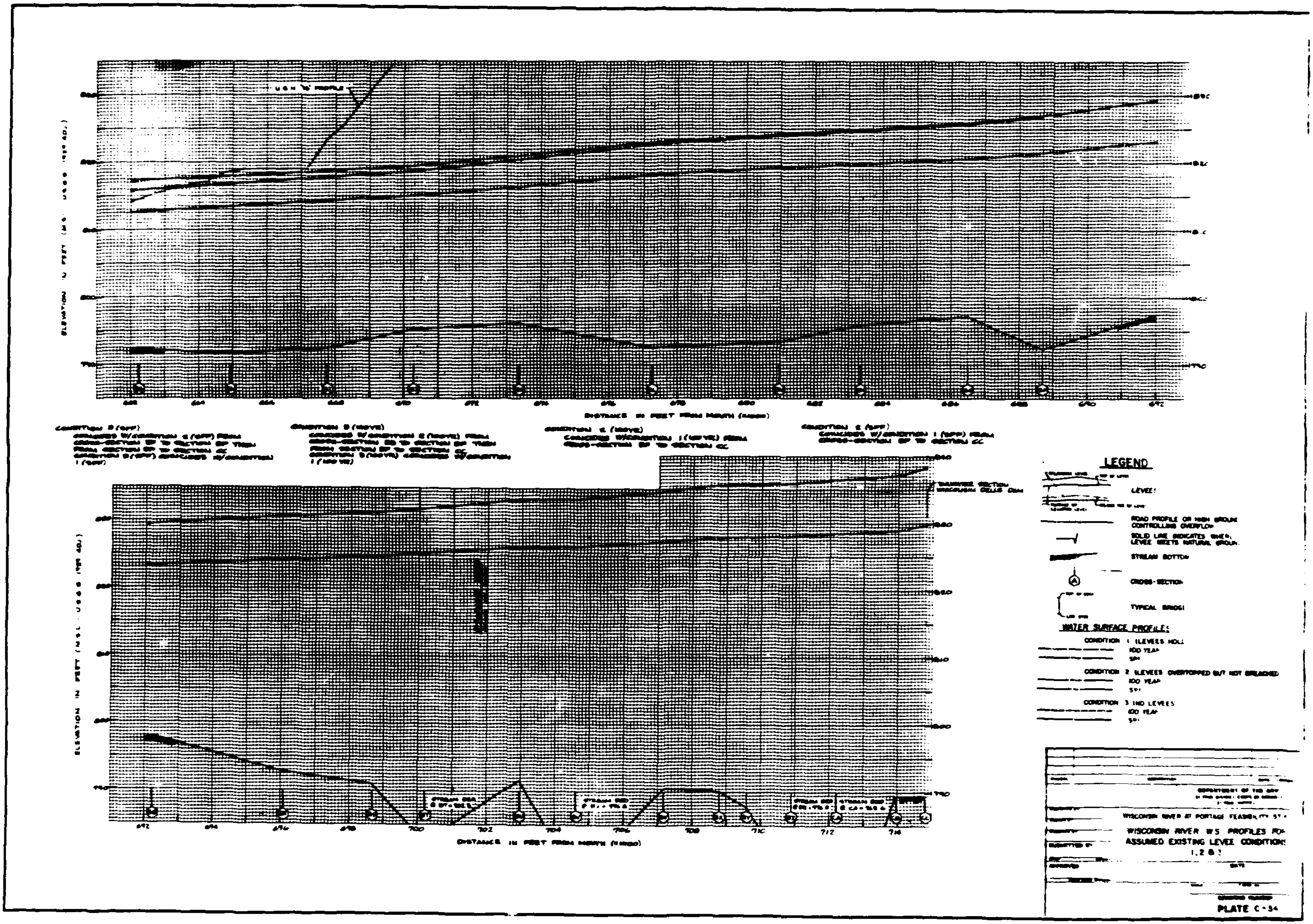
PLATE C-32



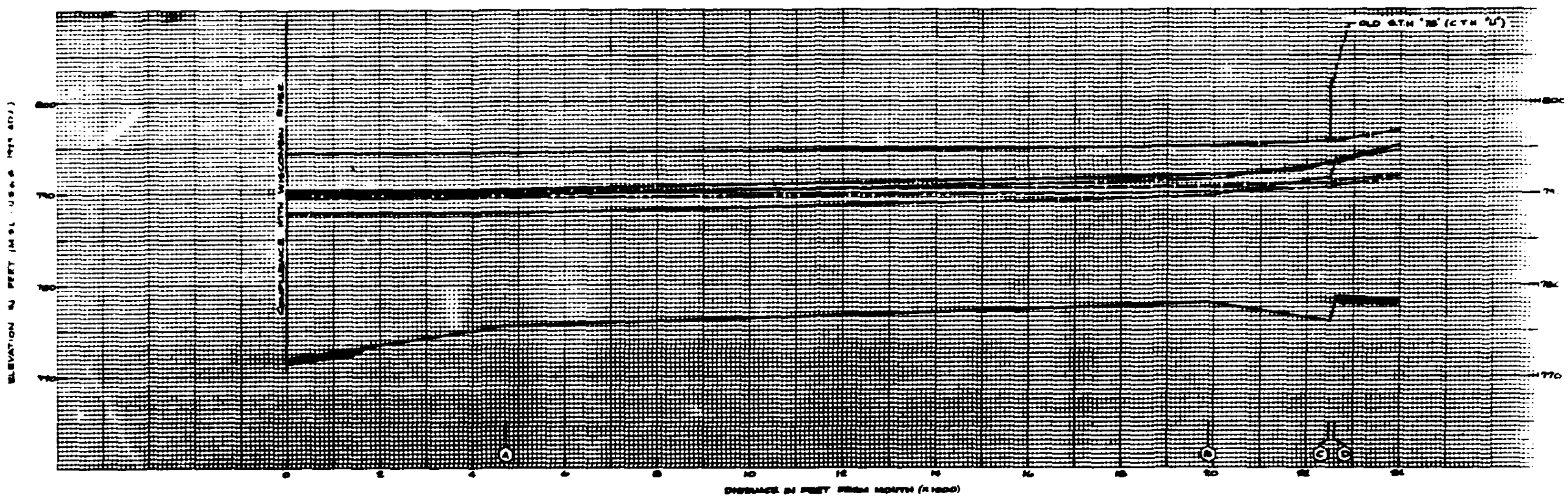
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

WISCONSIN RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3

PLATE C 3



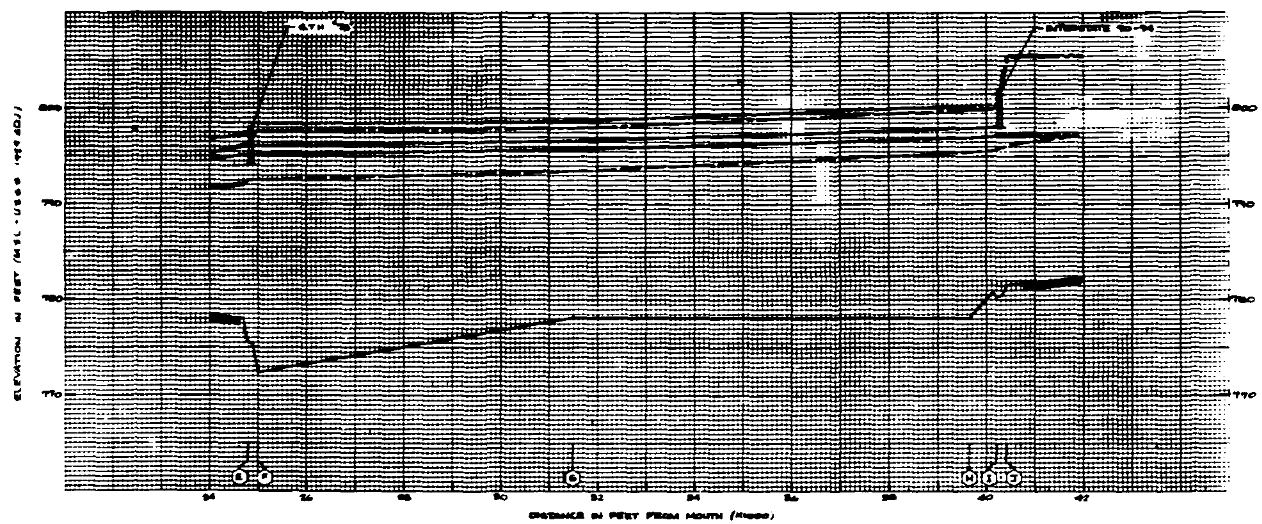
DISTANCE IN FEET FROM MOUTH
LEGEND
LEVEE
ROAD PROFILE OR HIGH GROUND CONTROLLING OVERFLOW
SOLID LINE INDICATES WHERE LEVEE MEETS NATURAL GROUND
STREAM BOTTOM
CROSS-SECTION
TYPICAL BRIDGE
WATER SURFACE PROFILES
CONDITION 1 (LEVEES HOLD)
100 YEAR
SPF
CONDITION 2 (LEVEES OVERTOPPED BUT NOT BREACHED)
100 YEAR
SPF
CONDITION 3 (NO LEVEES)
100 YEAR
SPF
WISCONSIN RIVER AT PORTAGE FEASIBILITY ST
WISCONSIN RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITIONS 1, 2 & 3
PLATE C-34



CONDITION 2 (100 YR)
COINCIDES WITH CONDITION 1 (100 YR)
FROM CROSS-SECTION E TO SECTION U

CONDITION 3 (100 YR)
COINCIDES WITH CONDITIONS 1 & 2 (100 YR)
FROM STATION 42 TO CROSS-SECTION U

CONDITION 3 (SPF)
COINCIDES WITH CONDITION 2 (SPF)
FROM CROSS-SECTION I TO CROSS-SECTION U



LEGEND

STREAM BOTTOM

CROSS-SECTION

TYPICAL BRIDGE

WATER SURFACE PROFILES

CONDITION 1 (LEVEES HOLD)
100 YEAR
SPF

CONDITION 2 (LEVEES OVERTOPPED BUT NOT BREACHED)
100 YEAR
SPF

CONDITION 3 (NO LEVEES)
100 YEAR
SPF

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

WISCONSIN RIVER AT PORTAGE FEASIBILITY ST.

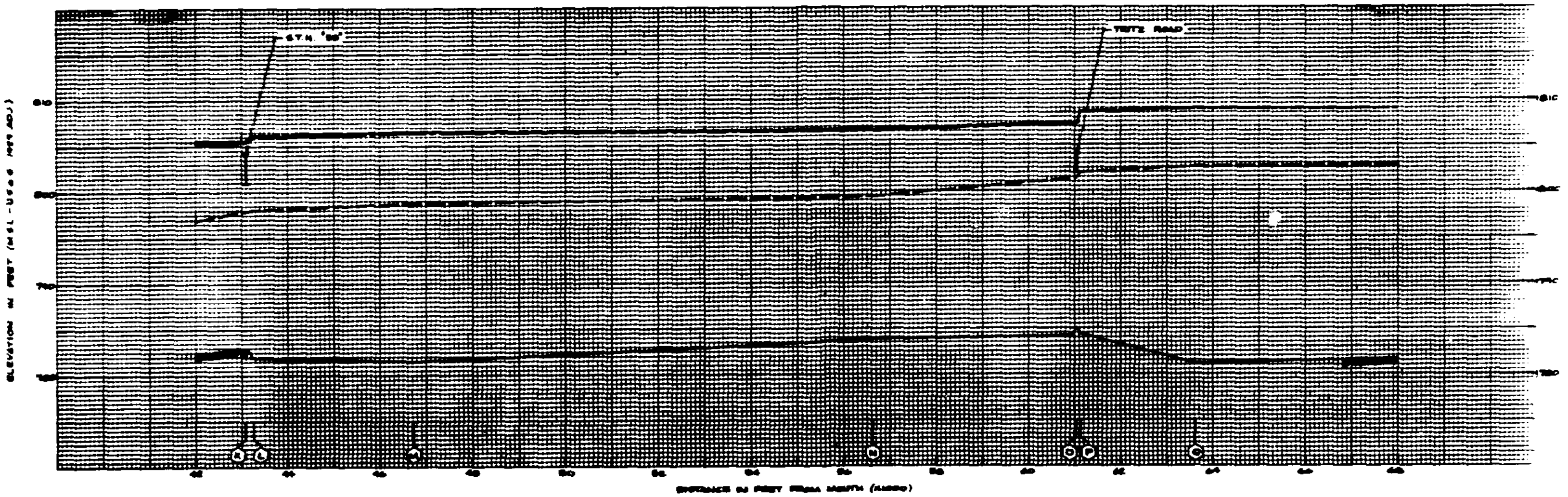
BARABOO RIVER W.S. PROFILES FOR
ASSUMED EXISTING LEVEE CONDITIONS
1, 2 & 3

SUBMITTED BY

APPROVED

DATE

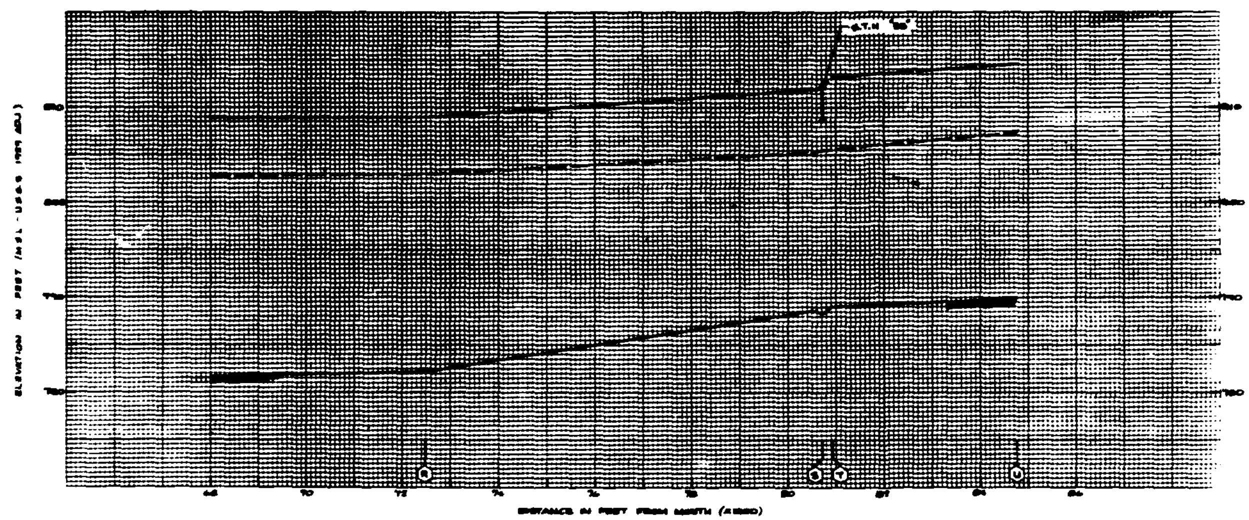
PLATE C-35



CONDITIONS 2 & 3 (100 YR)
CONCIDE WITH CONDITION 1 (100 YR)
FROM CROSS-SECTION I TO CROSS-SECTION U

CONDITION 3 (SPF)
COINCIDES WITH CONDITION 2 (SPF)
FROM CROSS SECTION I TO CROSS-SECTION U

CONDITIONS 2 & 3 (SPF)
COINCIDE WITH CONDITION 1 (SPF)
FROM CROSS SECTION P TO CROSS-SECTION U



LEGEND

STREAM BOTTOM

CROSS-SECTION

TYPICAL BRIDGE

WATER SURFACE PROFILES

CONDITION 1 (LEVEES HOLD)
100 YEAR
SPF

CONDITION 2 (LEVEES OVERTOPPED BUT NOT BREACHED)
100 YEAR
SPF

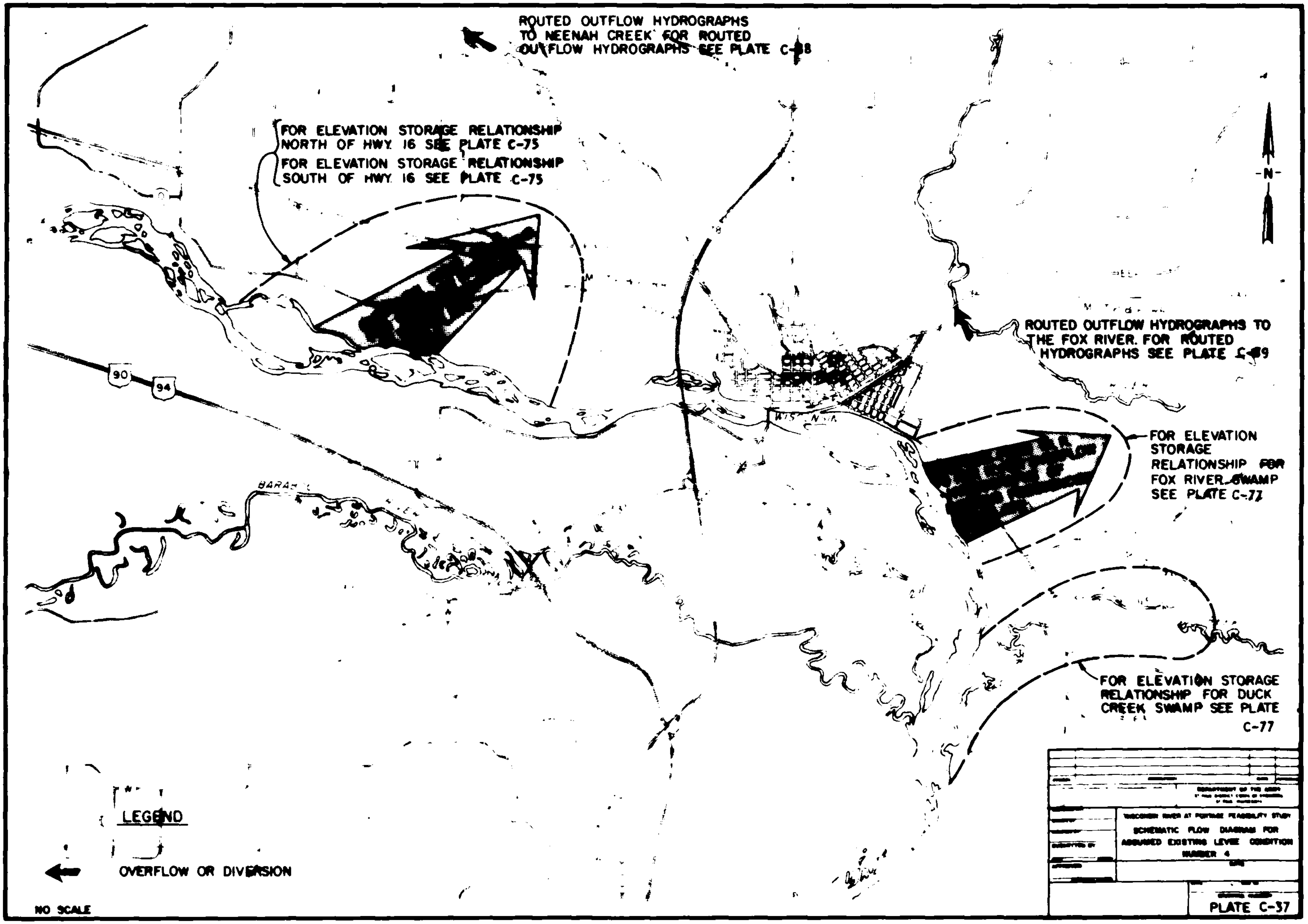
CONDITION 3 (NO LEVEES)
100 YEAR
SPF

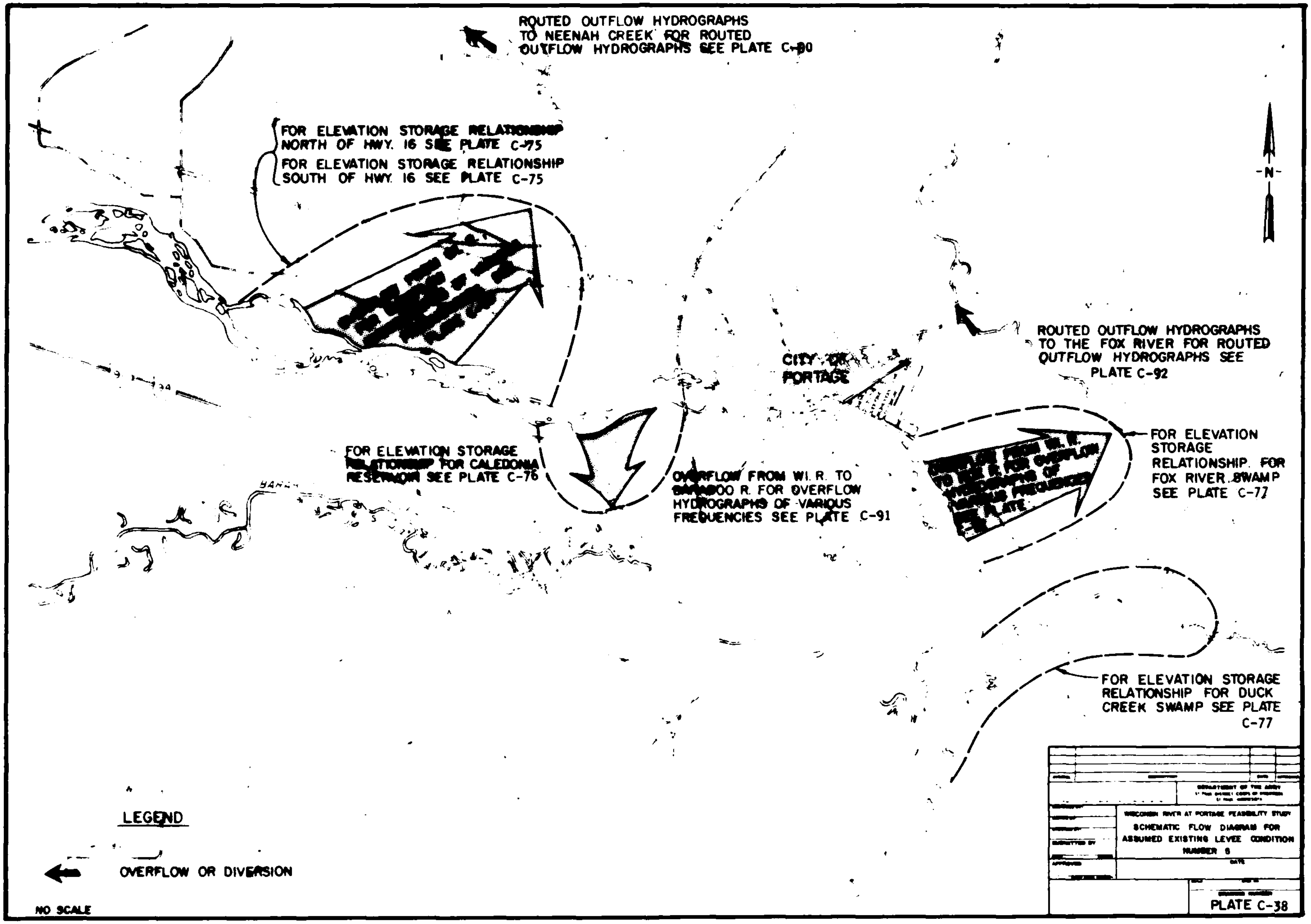
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

WISCONSIN RIVER AT PORTAGE FEASIBILITY ST.

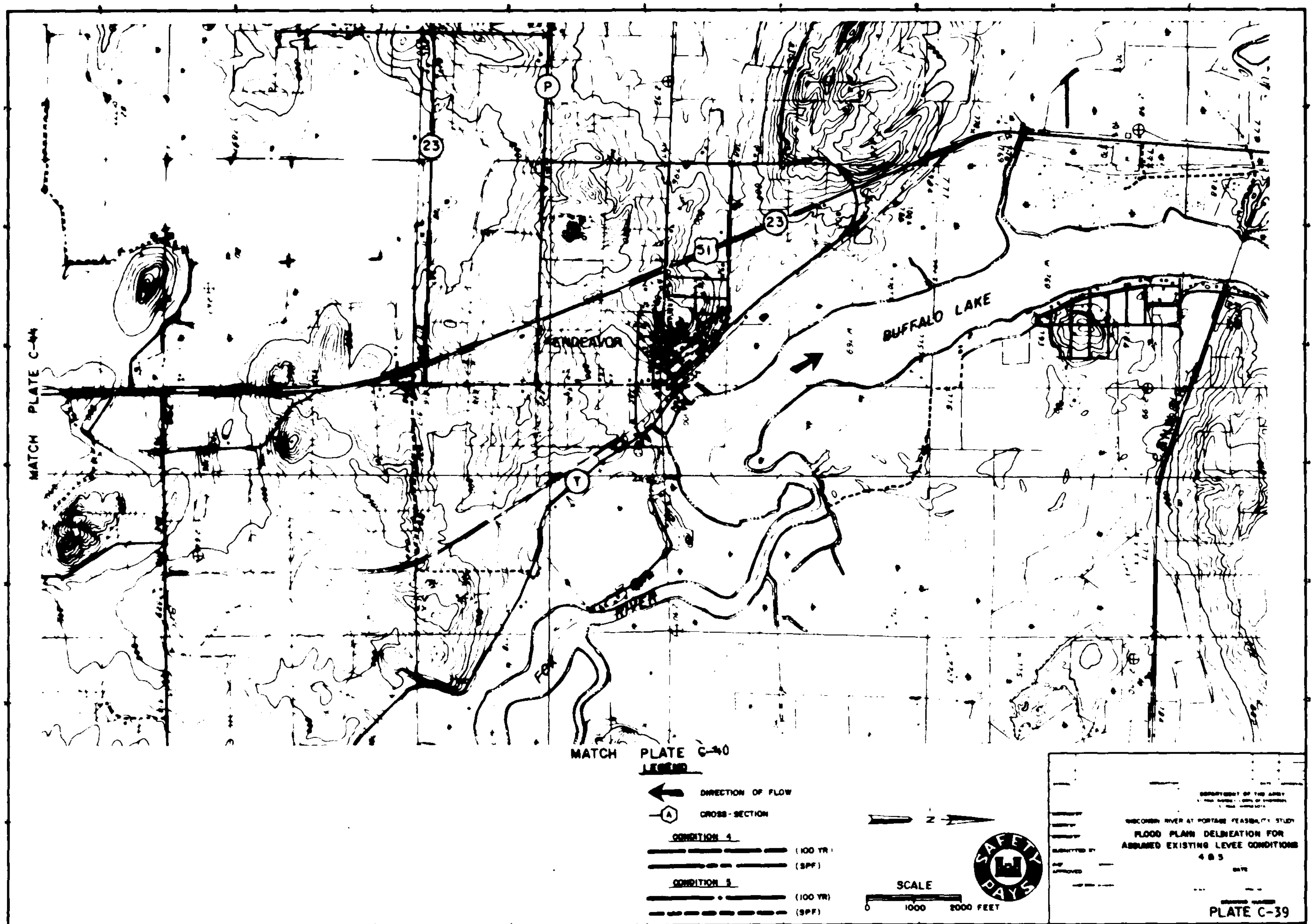
BARABOO RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITIONS (1, 2 & 3)

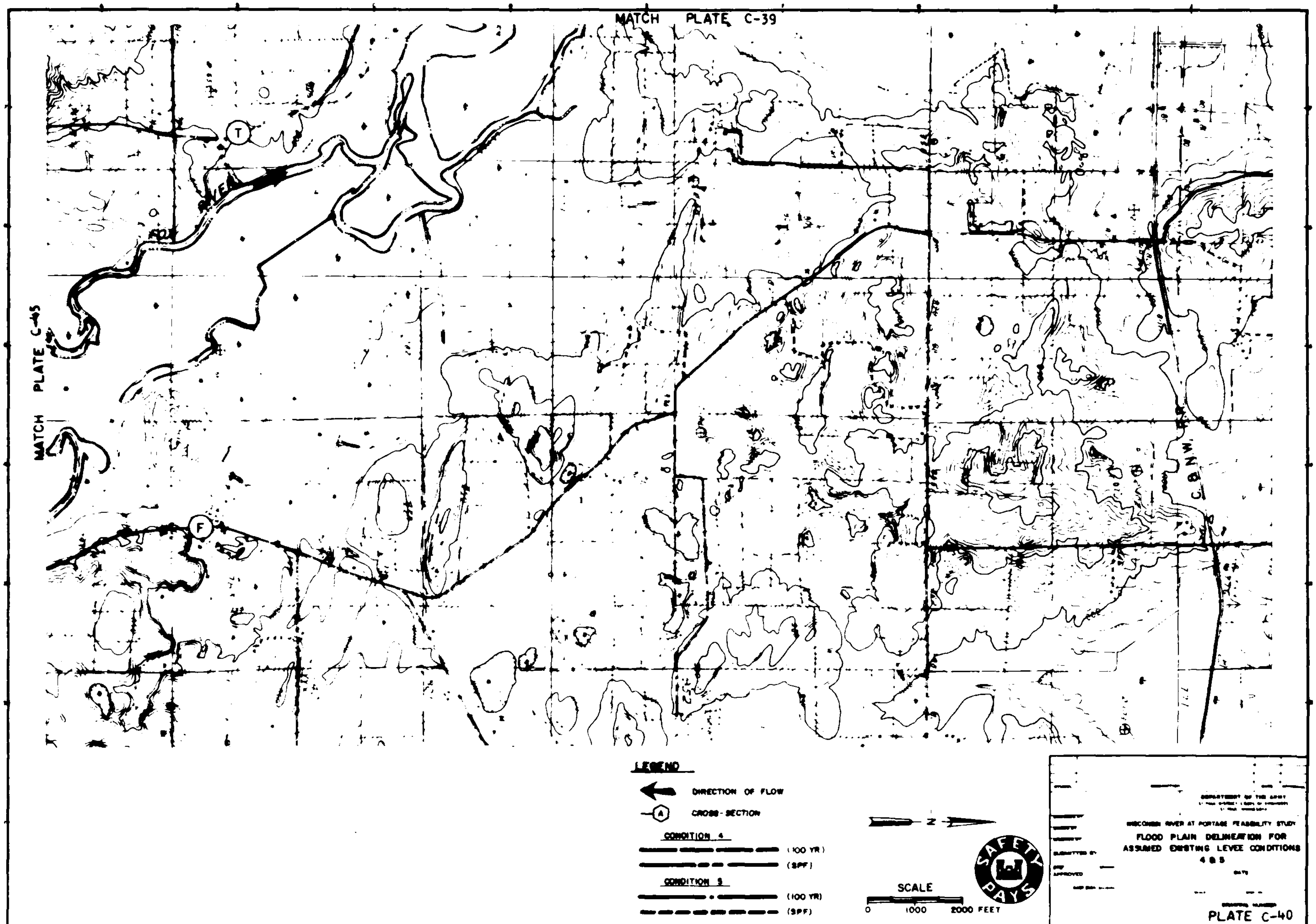
PLATE C-24

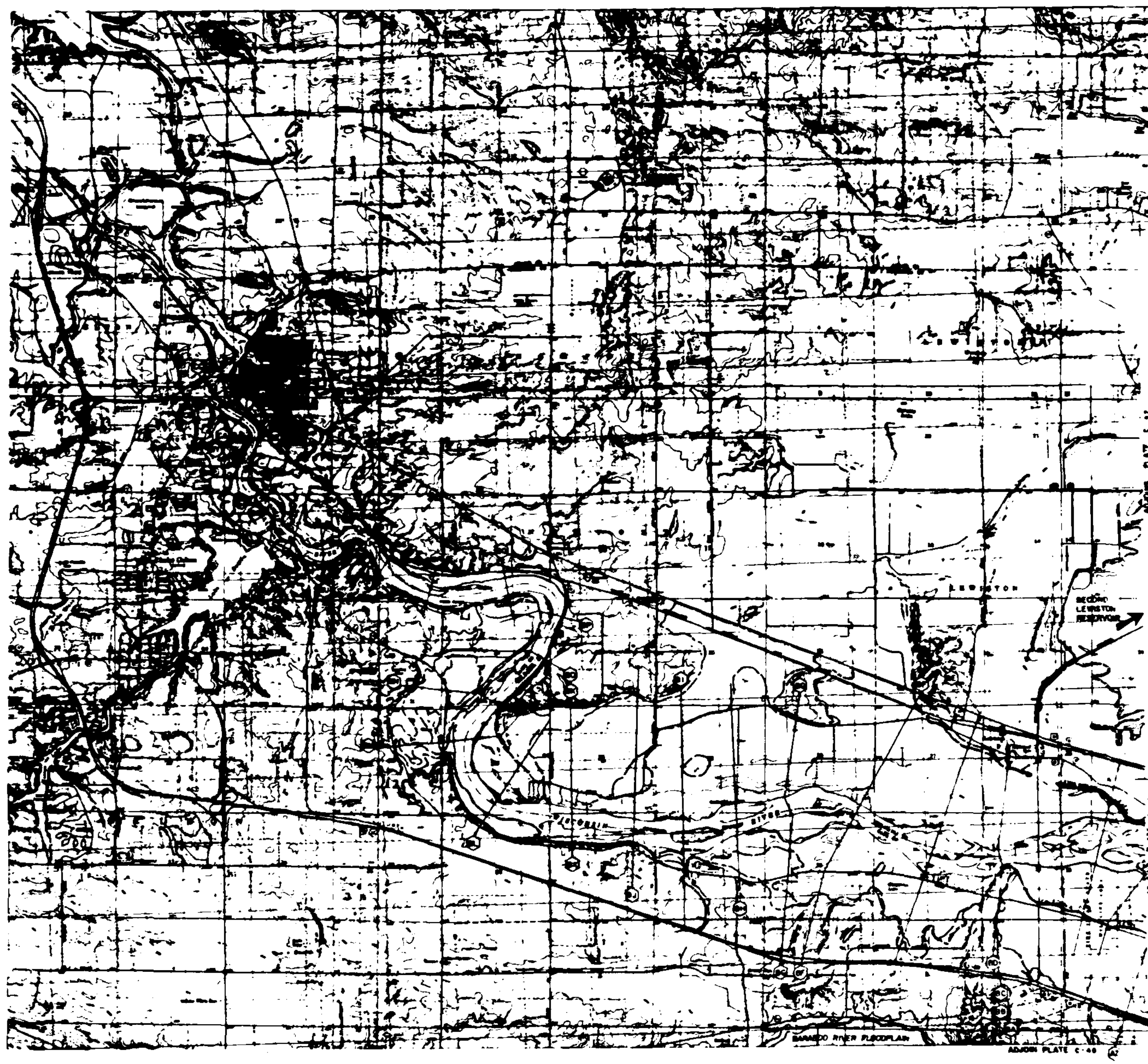

ROUTED OUTFLOW HYDROGRAPHS TO NEENAH CREEK FOR ROUTED OUTFLOW HYDROGRAPHS SEE PLATE C-78
FOR ELEVATION STORAGE RELATIONSHIP NORTH OF HWY 16 SEE PLATE C-75
FOR ELEVATION STORAGE RELATIONSHIP SOUTH OF HWY 16 SEE PLATE C-75
N
90
94
ROUTED OUTFLOW HYDROGRAPHS TO THE FOX RIVER. FOR ROUTED HYDROGRAPHS SEE PLATE C-79
FOR ELEVATION STORAGE RELATIONSHIP FOR FOX RIVER SWAMP SEE PLATE C-77
FOR ELEVATION STORAGE RELATIONSHIP FOR DUCK CREEK SWAMP SEE PLATE C-77
LEGEND
OVERFLOW OR DIVERSION
NO SCALE
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
SCHEMATIC FLOW DIAGRAM FOR ASSUMED EXISTING LEVEE CONDITION NUMBER 4
PLATE C-37



ROUTED OUTFLOW HYDROGRAPHS TO NEENAH CREEK FOR ROUTED OUTFLOW HYDROGRAPHS SEE PLATE C-90
FOR ELEVATION STORAGE RELATIONSHIP NORTH OF HWY. 16 SEE PLATE C-75
FOR ELEVATION STORAGE RELATIONSHIP SOUTH OF HWY. 16 SEE PLATE C-75
-N-
ROUTED OUTFLOW HYDROGRAPHS TO THE FOX RIVER FOR ROUTED OUTFLOW HYDROGRAPHS SEE PLATE C-92
CITY OF PORTAGE
FOR ELEVATION STORAGE RELATIONSHIP FOR CALEDONIA RESERVOIR SEE PLATE C-76
OVERFLOW FROM WI. R. TO BARABOO R. FOR OVERFLOW HYDROGRAPHS OF VARIOUS FREQUENCIES SEE PLATE C-91
FOR ELEVATION STORAGE RELATIONSHIP. FOR FOX RIVER SWAMP SEE PLATE C-77
FOR ELEVATION STORAGE RELATIONSHIP FOR DUCK CREEK SWAMP SEE PLATE C-77
LEGEND
OVERFLOW OR DIVERSION
NO SCALE
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
SCHEMATIC FLOW DIAGRAM FOR ASSUMED EXISTING LEVEE CONDITION NUMBER 5
PLATE C-38


MATCH PLATE C-44
MATCH PLATE C-40
BUFFALO LAKE
ENDEAVOR
FOX RIVER
23
51
P
Y
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 4
(100 YR)
(SPF)
CONDITION 5
(100 YR)
(SPF)
N
SCALE
0 1000 2000 FEET
SAFETY PAYS
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
4 & 5
PLATE C-39


MATCH PLATE C-39
MATCH PLATE C-45
T
F
C&NW
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 4
(100 YR)
(SPF)
CONDITION 5
(100 YR)
(SPF)
N
SCALE
0 1000 2000 FEET
SAFETY PAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
4 & 5
PLATE C-40



LATERAL RESERVOIRS PEAK STAGES (FT)

	LC 4		LC 5	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	*	*	798	80[illegible]
SECOND LEWISTON RES	792	800	792	80[illegible]
CALEDONIA RES	*	*	794	79[illegible]
FOR R SWAMP RES	—	783	791	790

* FOR THESE CONDITIONS THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

GENERAL NOTES

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED:
   1. LEVEE CONDITION 4 (100 YEAR) THEN (SPF)
   2. LEVEE CONDITION 5 (100 YEAR) THEN (SPF)

LEGEND

DIRECTION OF FLOW

(A) CROSS SECTION

CONDITION 4

(100 YEAR

(SPF

CONDITION 5

(100 YEAR

(SPF

SCALE

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

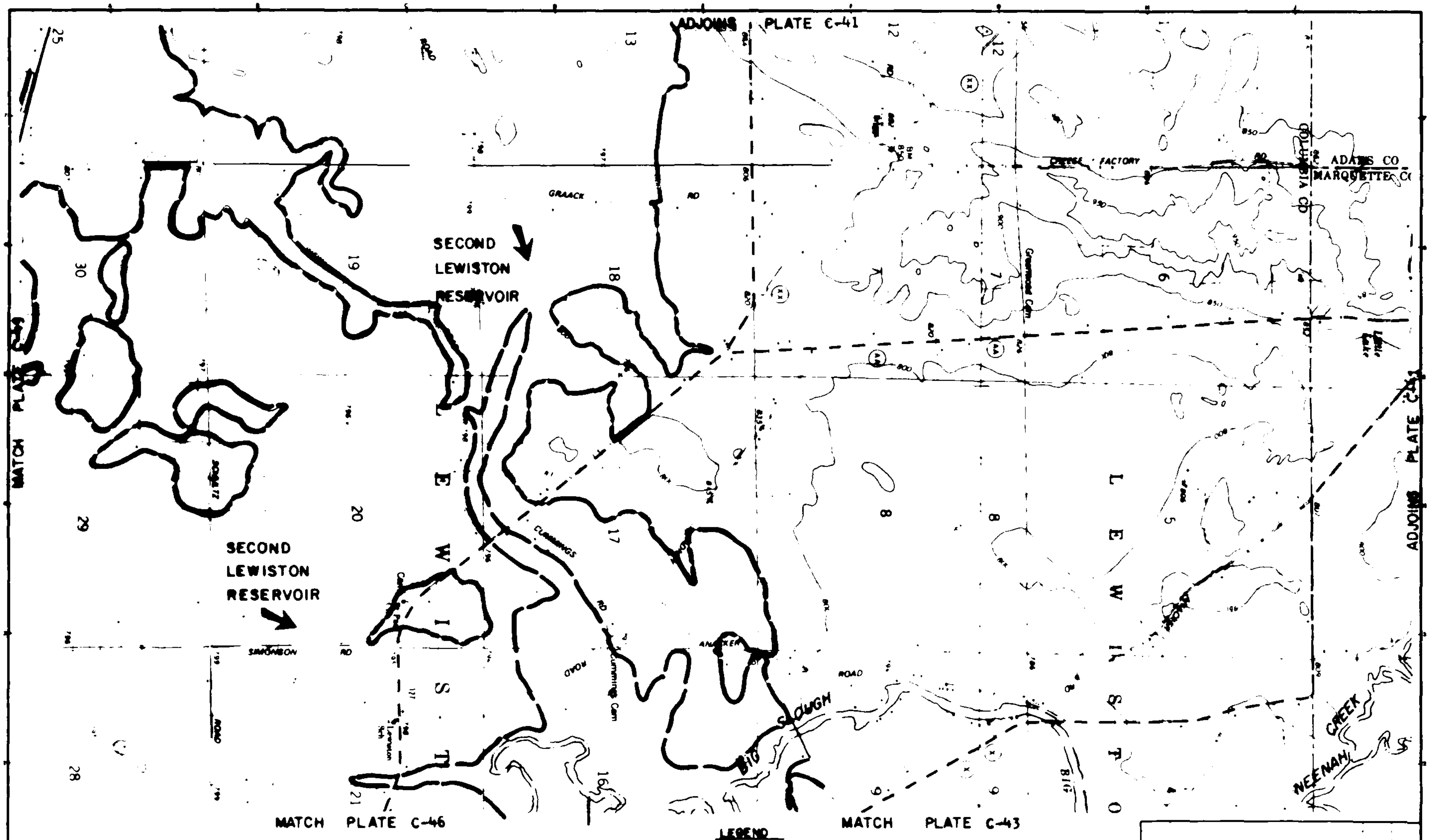
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

SUBMITTED BY

APPROVED

DATE

PLATE C-4



LATERAL RESERVOIRS PEAK STAGES (FT.)

	L.C. 4		L.C. 5	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	*	*	798	801
SECOND LEWISTON RES	792	800	792	801
CALEDONIA RES	*	*	794	795
FOX R. SWAMP RES	–	783	791	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY.

GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS.
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR THE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR.), THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR.), THEN (SPF)

LEGEND

DIRECTION OF FLOW

(A) CROSS-SECTION

CONDITION 4

(100 YR)

(SPF)

CONDITION 5

(100 YR)

(SPF)

N

SCALE

0 1000 2000 FEET

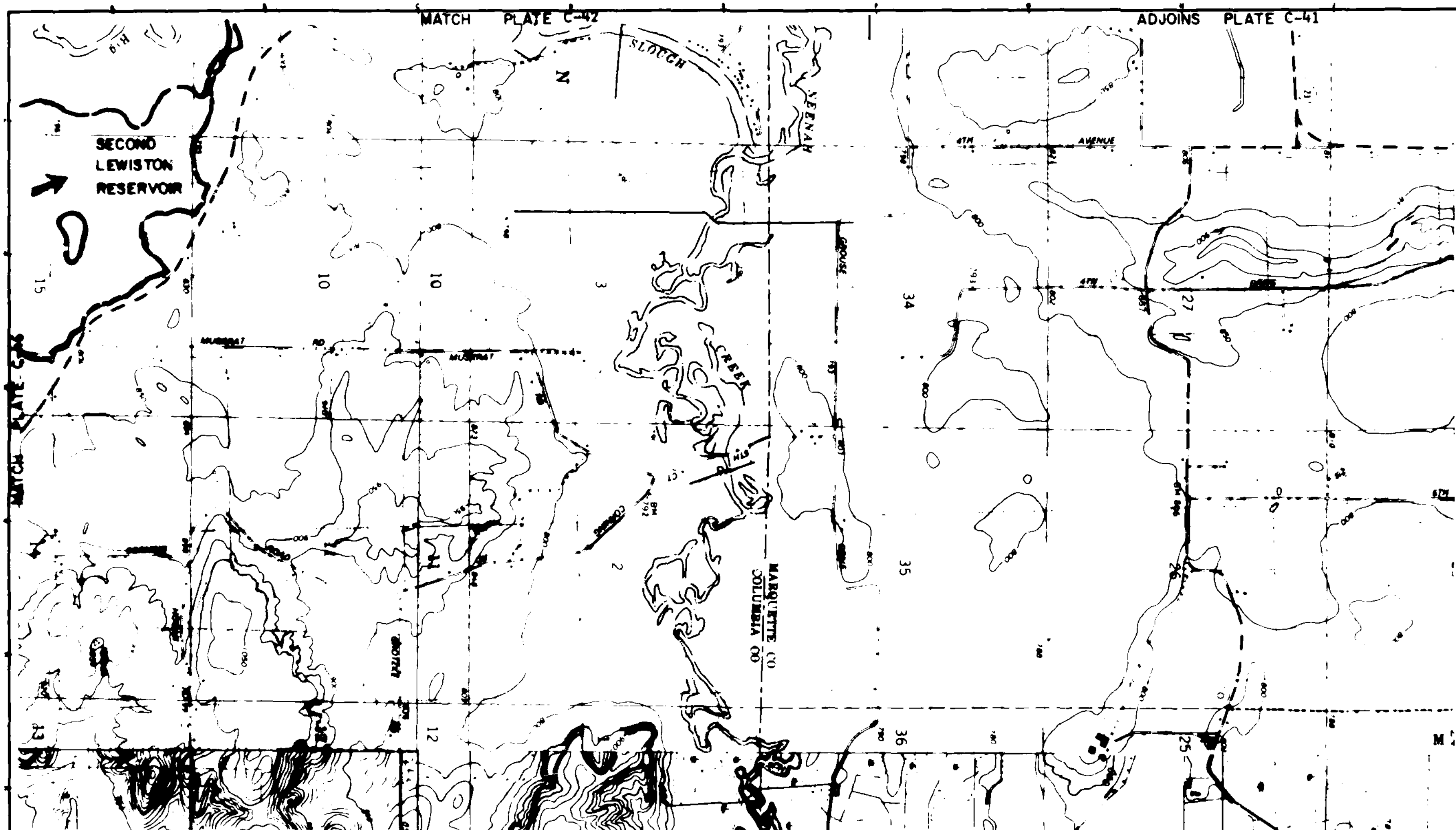
SAFETY PAYS

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

PLATE C-42



LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 4

(100 YR)

(SPF)

CONDITION 5

(100 YR)

(SPF)

SCALE

0 1000 2000 FEET

GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR), THEN (SPF)

LATERAL RESERVOIRS PEAK STAGES (FT.)

	L.C. 4		L.C. 5	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	*	*	796	801
SECOND LEWISTON RES	792	800	79[illegible]	801
CALEDONIA RES	*	*	794	796
FOX R. SWAMP RES	—	783	791	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

SAFETY PAYS

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

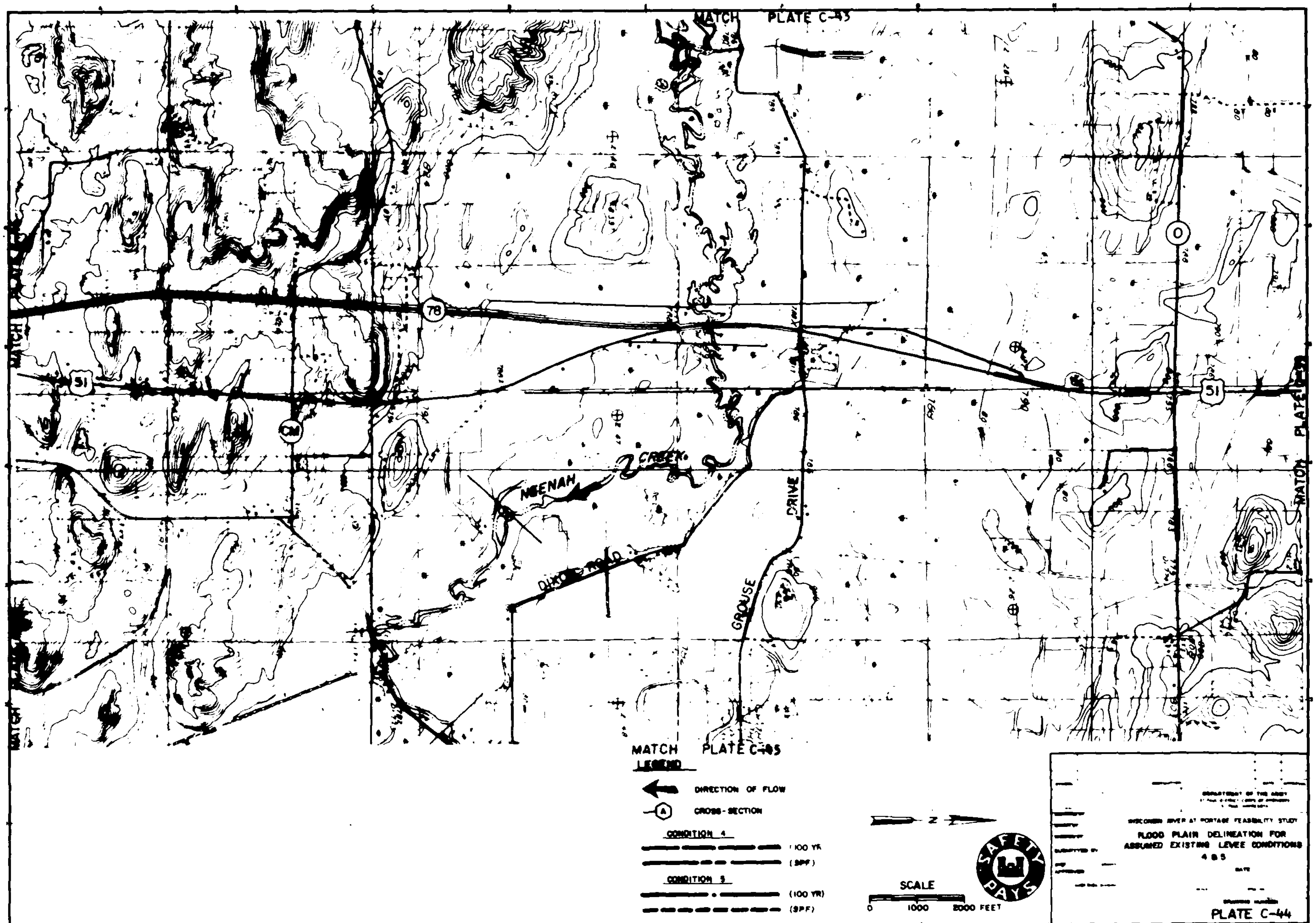
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

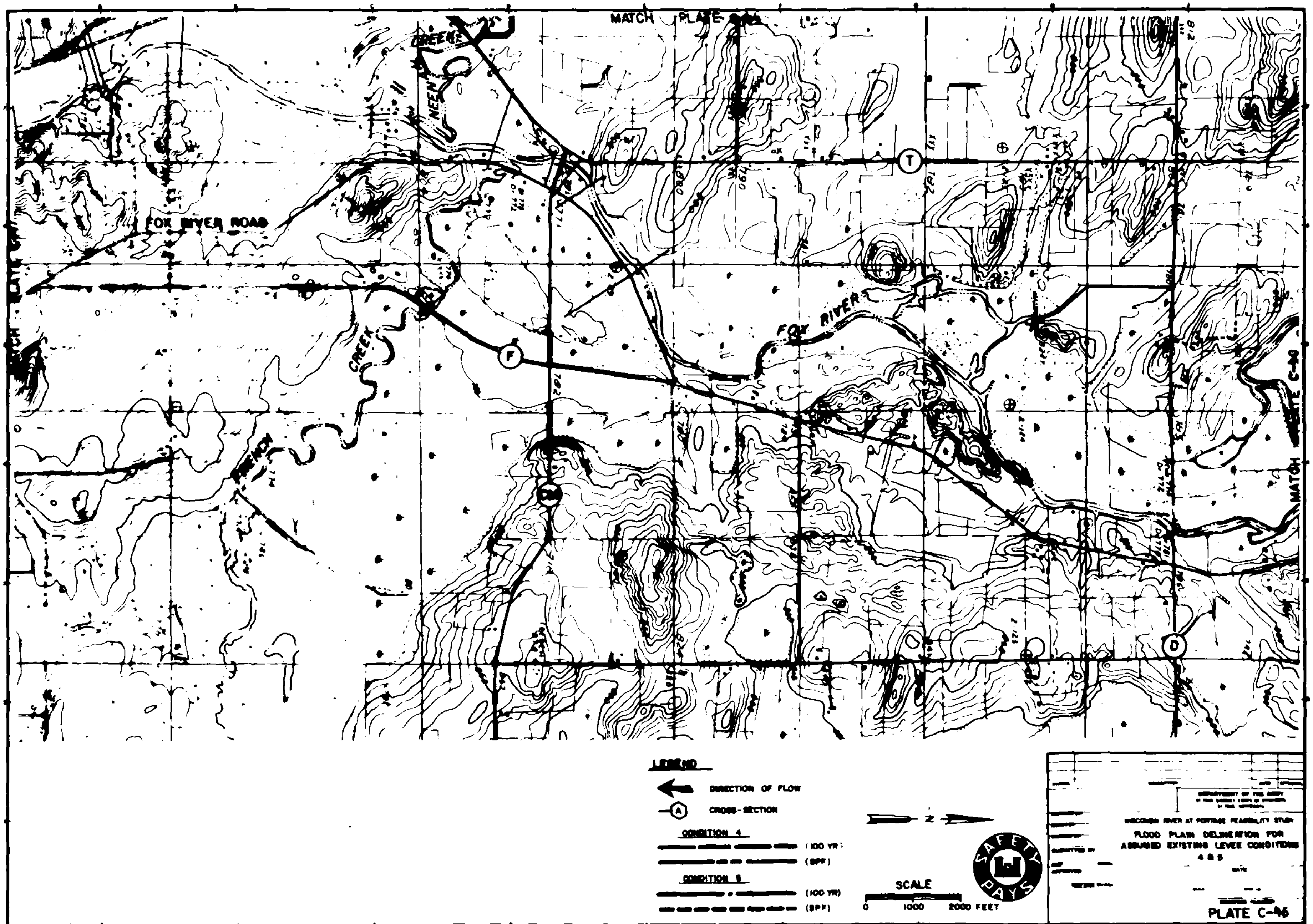
SUBMITTED BY

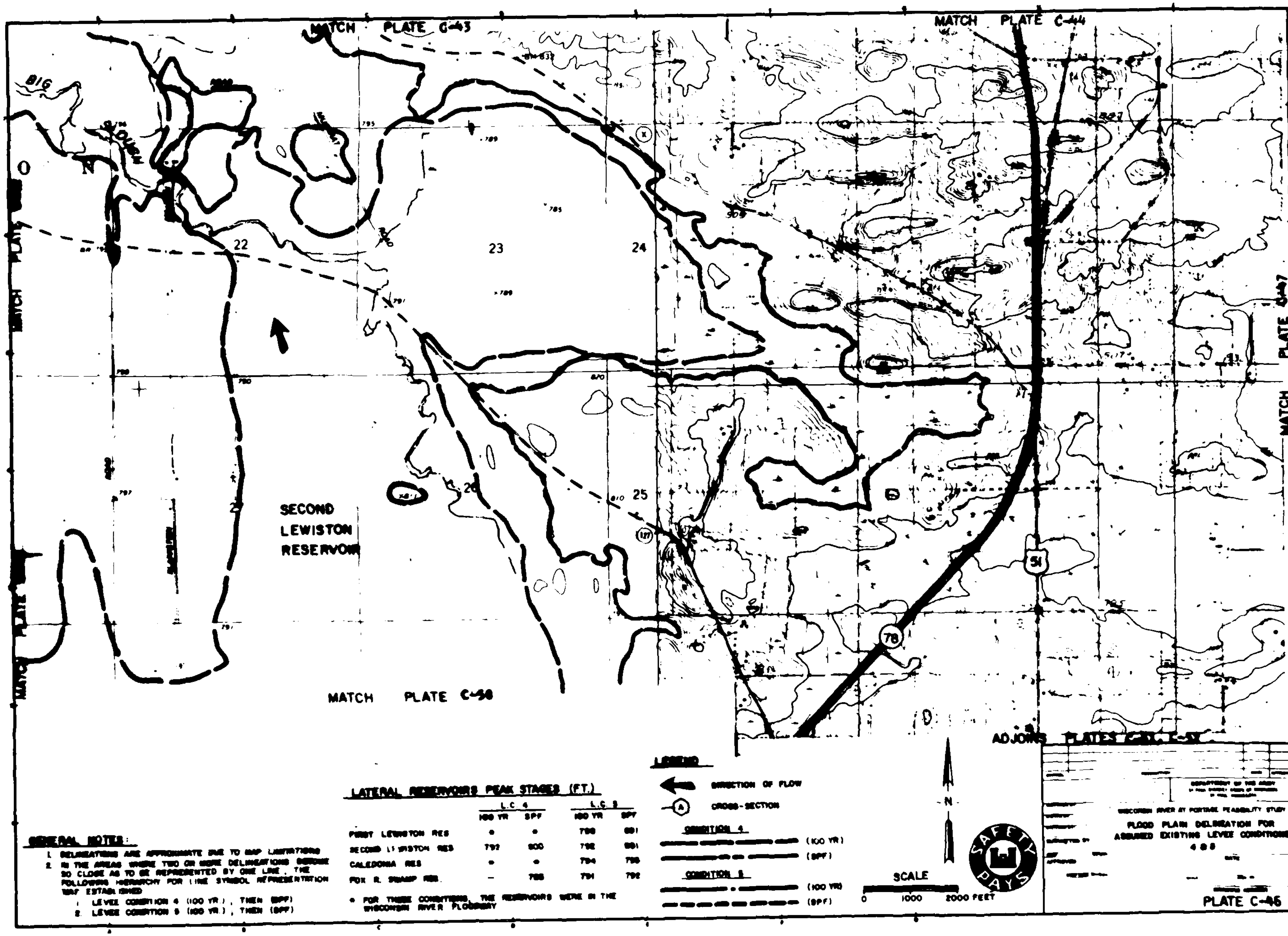
APPROVED

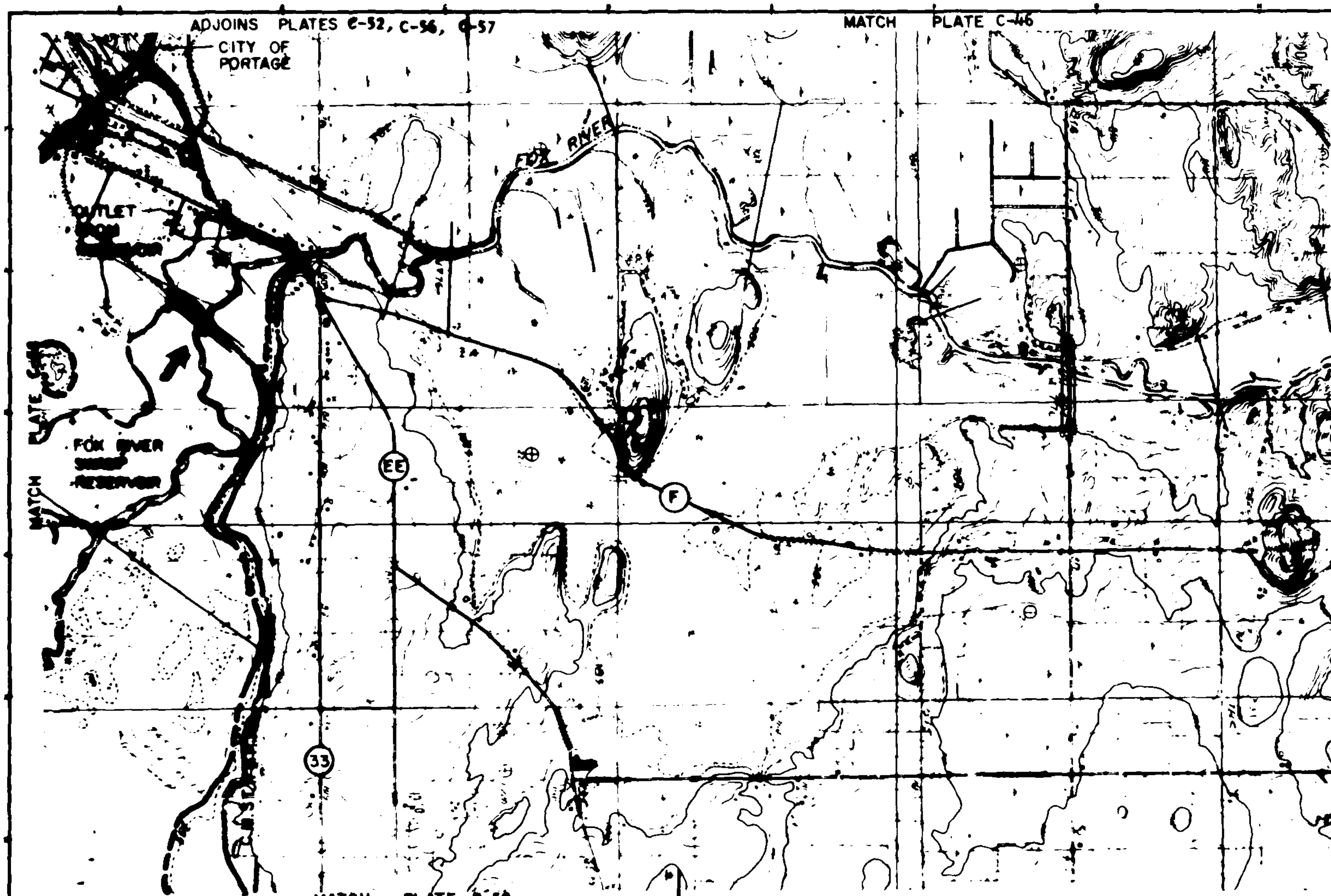
DATE

PLATE C-43


MATCH PLATE C-43
MATCH PLATE C-45
51
78
O
CM
NEENAH CREEK
GROUSE DRIVE
DIXON ROAD
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 4
(100 YR)
(SPF)
CONDITION 5
(100 YR)
(SPF)
N
SCALE
0 1000 2000 FEET
SAFETY PAYS
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
4 & 5
PLATE C-44


MATCH PLATE C-44
MATCH PLATE C-46
FOX RIVER ROAD
FOX RIVER
CREEK
NEENAH
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 4
(100 YR)
(SPF)
CONDITION 5
(100 YR)
(SPF)
N
SCALE
0 1000 2000 FEET
SAFETY PAYS
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
4 & 5
PLATE C-45


MATCH PLATE C-43
MATCH PLATE C-44
MATCH PLATE C-47
MATCH PLATE C-50
BIG SLOUGH
22
23
24
25
SECOND LEWISTON RESERVOIR
51
78
ADJOINS PLATES
GENERAL NOTES:
1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
1. LEVEE CONDITION 4 (100 YR.), THEN (SPF)
2. LEVEE CONDITION 5 (100 YR.), THEN (SPF)
LATERAL RESERVOIRS PEAK STAGES (FT.)
L.C. 4 100 YR SPF
L.C. 5 100 YR SPF
FIRST LEWISTON RES * * 798 801
SECOND LEWISTON RES 792 800 792 801
CALEDONIA RES * * 794 798
FOX R. SWAMP RES. — 788 791 792
* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY
LEGEND
DIRECTION OF FLOW
A CROSS-SECTION
CONDITION 4
(100 YR)
(SPF)
CONDITION 5
(100 YR)
(SPF)
N
SCALE
0 1000 2000 FEET
SAFETY PAYS
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS
4 & 5
PLATE C-46



GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR), THEN (SPF)

LATERAL RESERVOIRS PEAK STAGES (FT.)

	L.C. 4		L.C. 5	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	*	*	798	801
SECOND LEWISTON RES	792	800	792	801
CALEDONIA RES	*	*	794	796
FOX R. SWAMP RES	–	793	791	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

LEGEND

DIRECTION OF FLOW

(A) CROSS-SECTION

CONDITION 4

(100 YR)

(SPF)

CONDITION 5

(100 YR)

(SPF)

N

SCALE

0 1000 2000 FEET

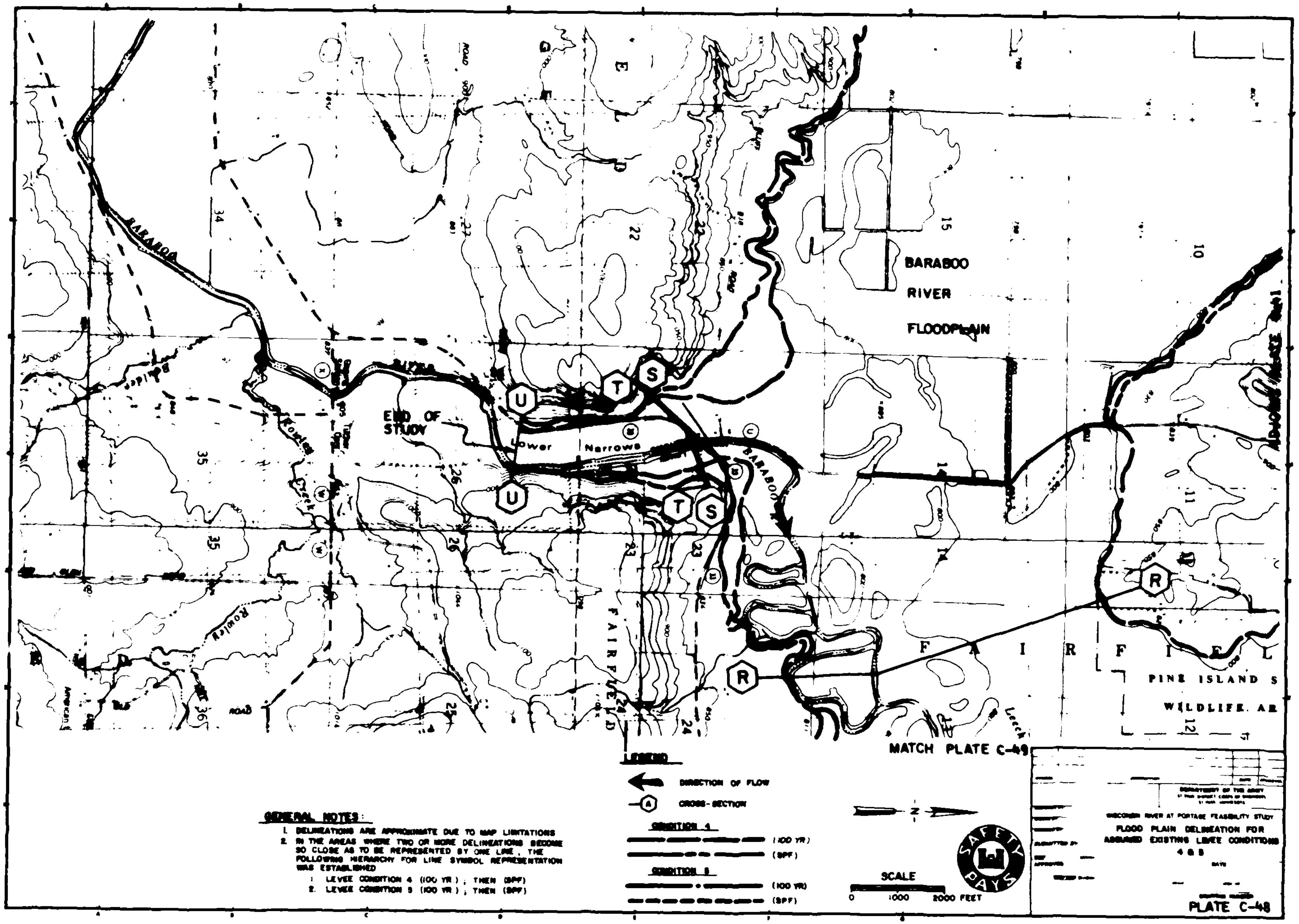
SAFETY PAYS

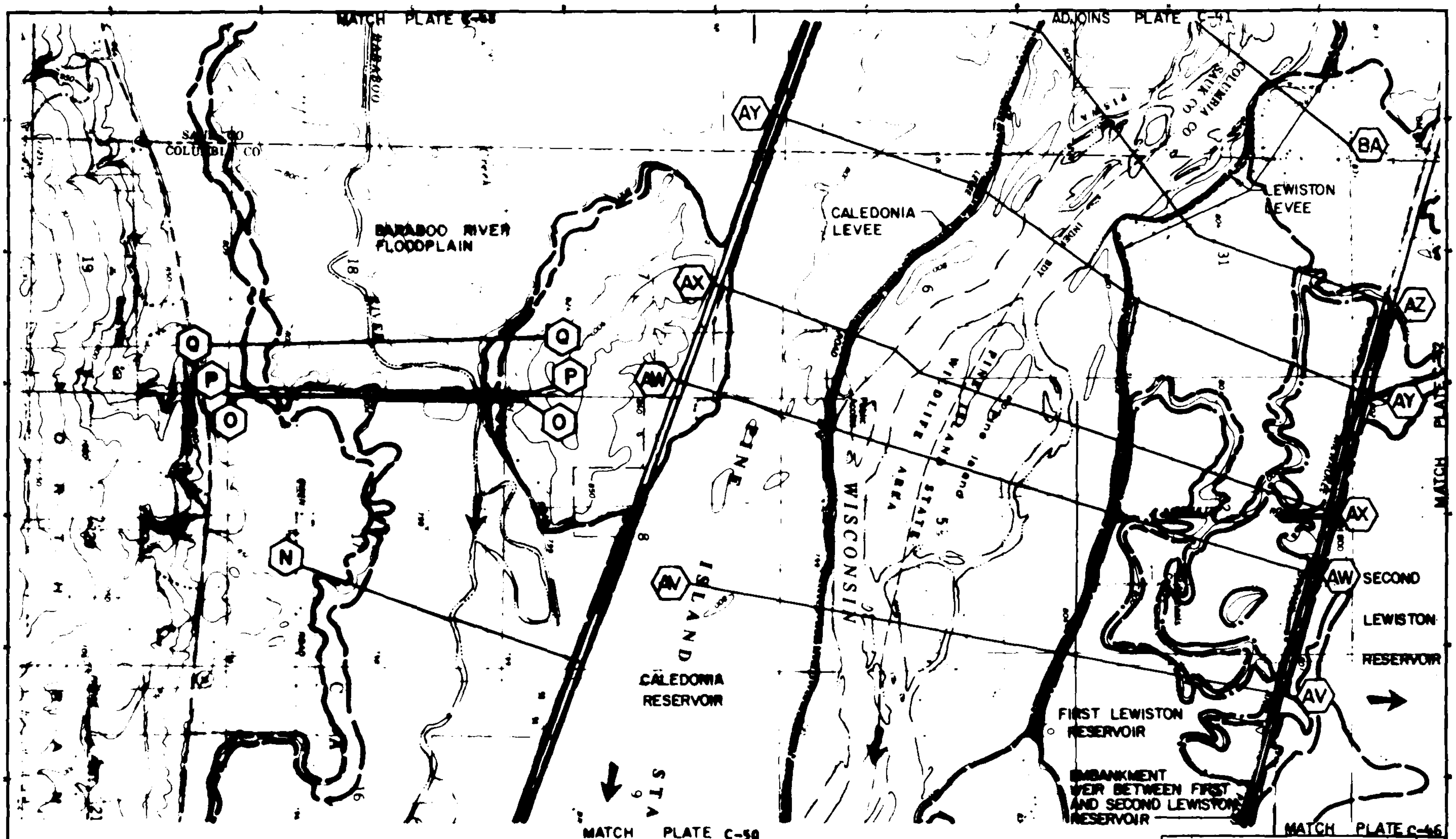
DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

PLATE C-47


BARABOO RIVER FLOODPLAIN
PINE ISLAND S
WILDLIFE AR
FAIRFIELD
Lower Narrows
END OF STUDY
BARABOO R
BARABOO
Rowley Creek
Leech
MATCH PLATE C-49
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 4
(100 YR)
(SPF)
CONDITION 5
(100 YR)
(SPF)
GENERAL NOTES:
1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
1. LEVEE CONDITION 4 (100 YR); THEN (SPF)
2. LEVEE CONDITION 5 (100 YR); THEN (SPF)
SCALE
0 1000 2000 FEET
SAFETY PAYS
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5
PLATE C-48



MATCH PLATE C-50

LEGEND

DIRECTION OF FLOW

CROSS SECTION

CONDITION 4 (100 YR) (SPF)

CONDITION 5 (100 YR) (SPF)

SCALE 0 1000 2000 FEET

LATERAL RESERVOIRS PEAK STAGES (FT)

	L C 4 100 YR	L C 4 SPF	L C 5 100 YR	L C 5 SPF
FIRST LEWISTON RES	*	*	798	801
SECOND LEWISTON RES	792	800	792	801
CALEDONIA RES	*	*	794	798
FOX R SWAMP RES	–	783	791	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR), THEN (SPF)

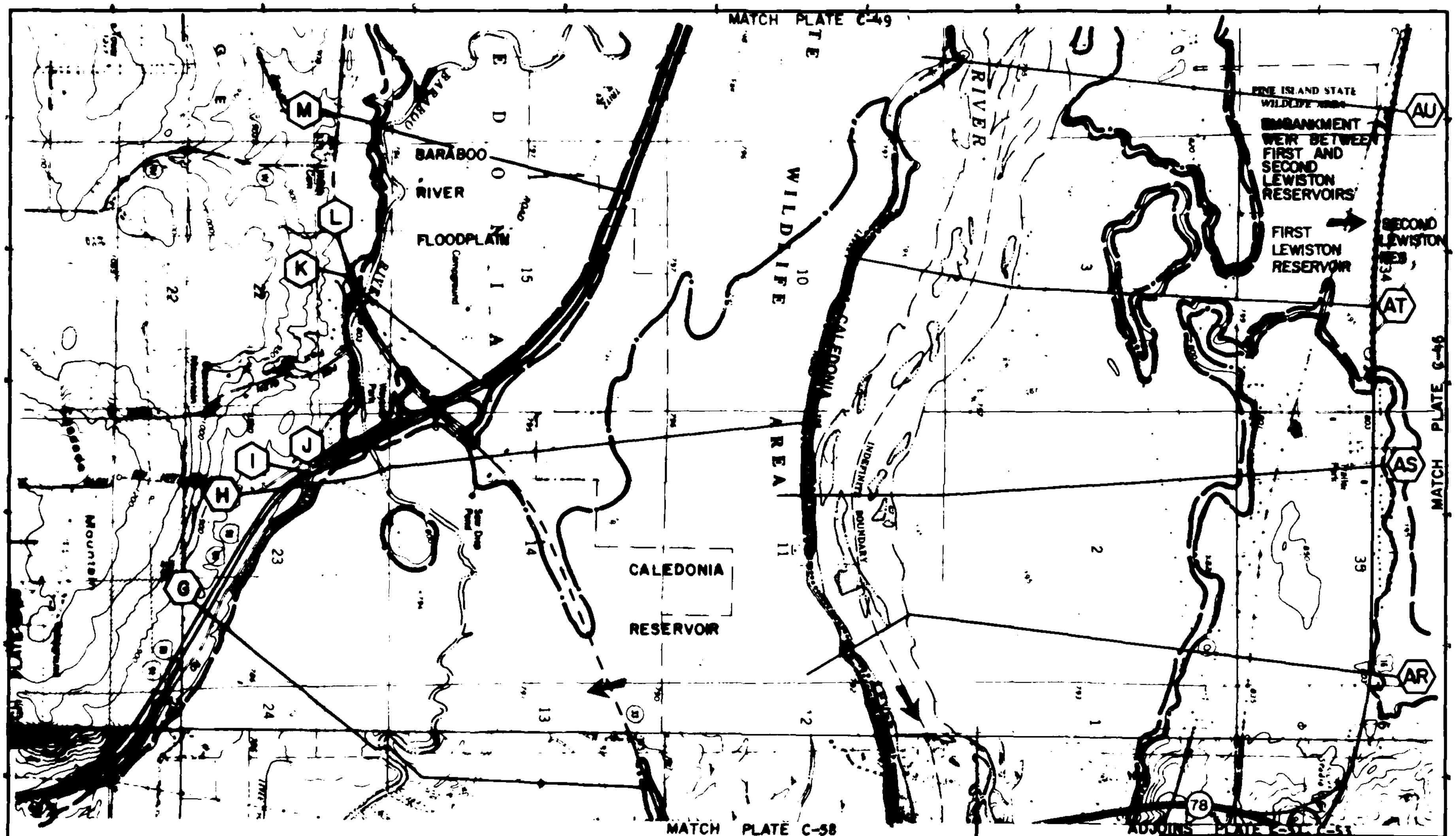
DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

DATE

PLATE C-49



LEGEND

DIRECTION OF FLOW

(A) CROSS-SECTION

CONDITION 4
(100 YR.)
(SPF)

CONDITION 5
(100 YR)
(SPF)

N

SCALE
0 1000 2000 FEET

LATERAL RESERVOIRS PEAK STAGES (FT)

	L.C 4		L.C 5	
	100 YR.	SPF	100 YR	SPF
FIRST LEWISTON RES	*	*	798	801
SECOND LEWISTON RES	792	800	792	801
CALEDONIA RES	*	*	794	798
FOX R. SWAMP RES.	—	783	791	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR.), THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR.), THEN (SPF)

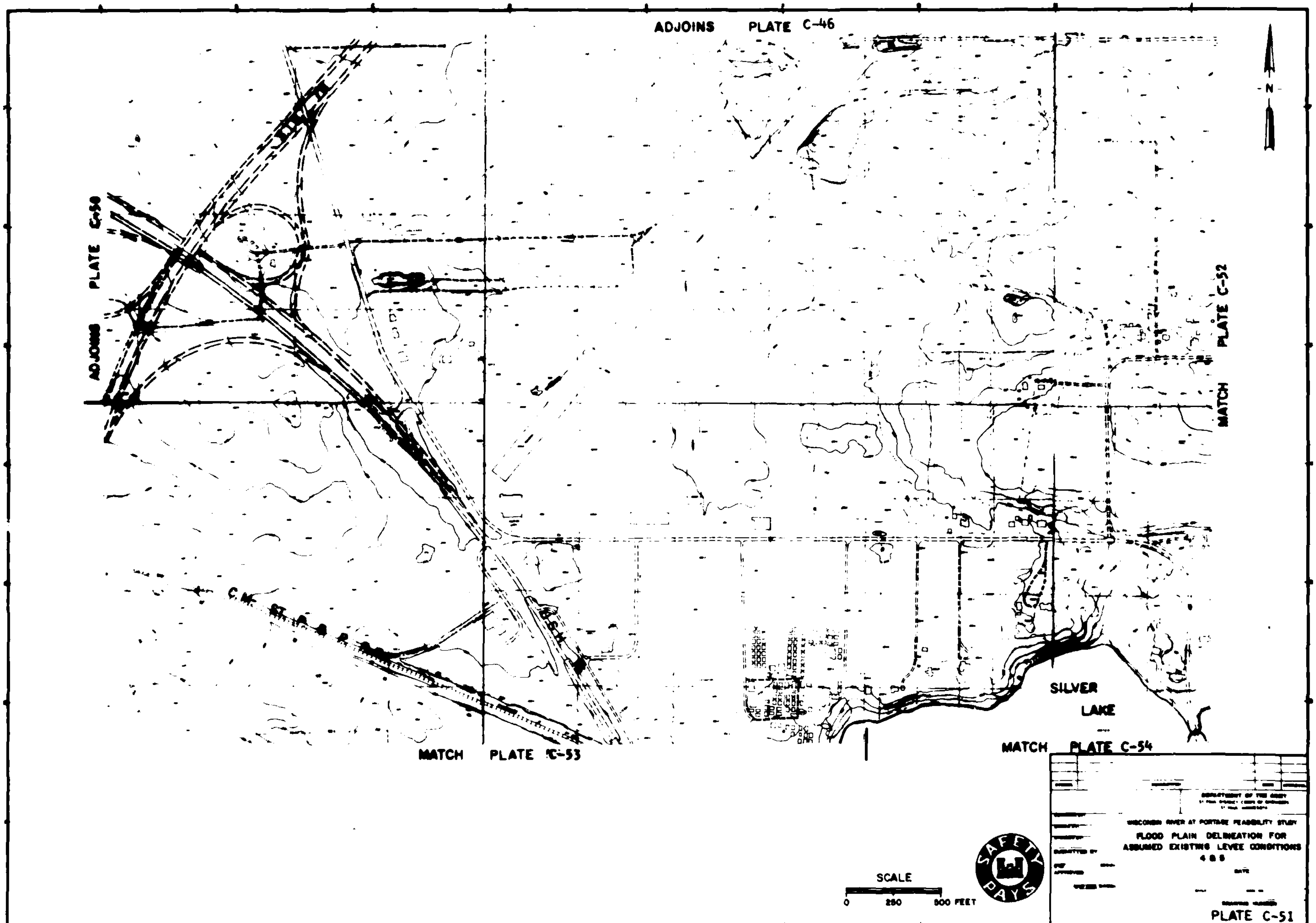
SAFETY PAYS

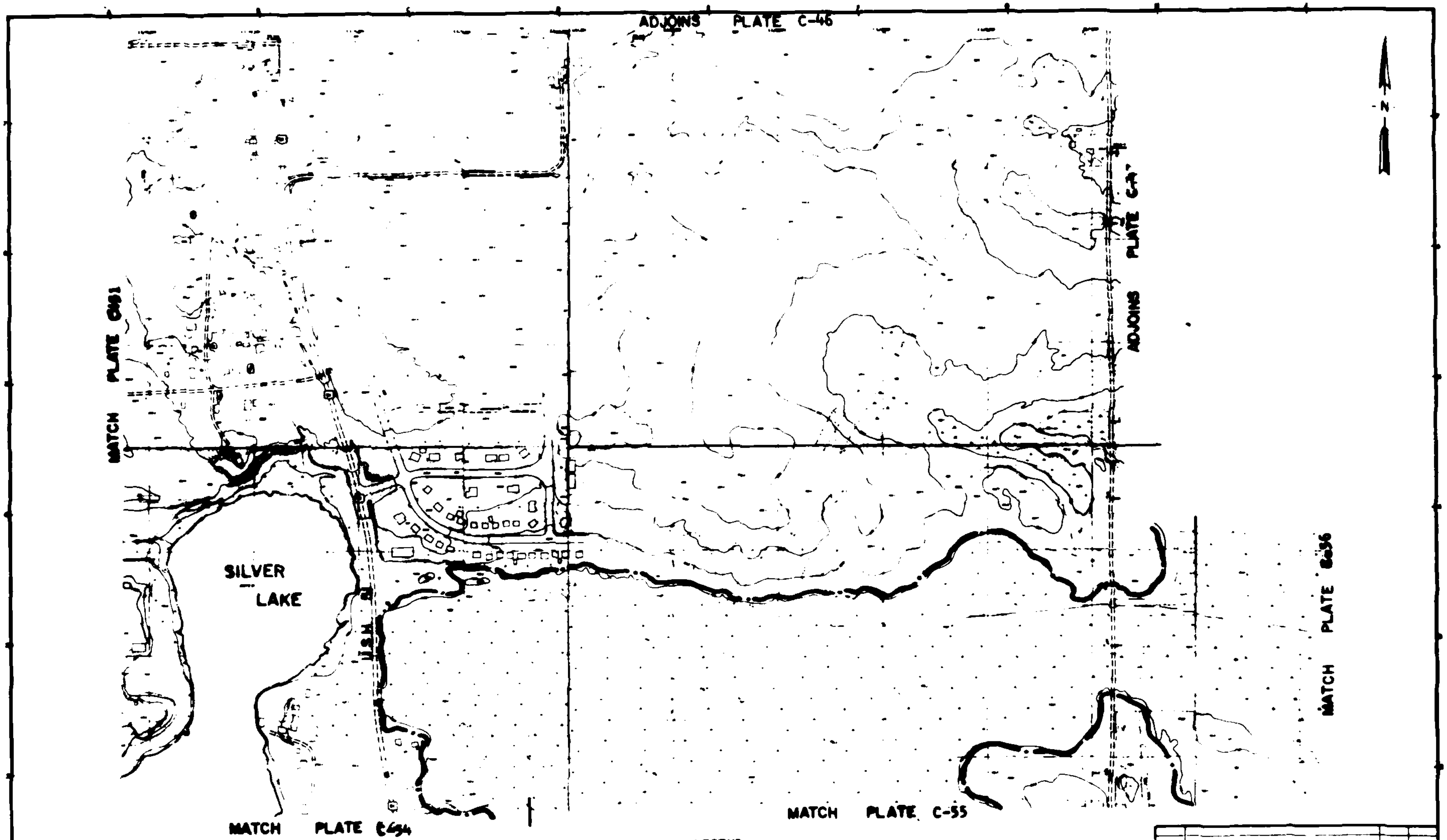
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

PLATE C-50


ADJOINS PLATE C-46
ADJOINS PLATE C-50
MATCH PLATE C-52
MATCH PLATE C-53
MATCH PLATE C-54
N
C.M. ST. P. & P. R.R.
SILVER
LAKE
SCALE
0 250 500 FEET
SAFETY PAYS
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
PLATE C-51



GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR.); THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR.); THEN (SPF)

LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 4
(100 YR)
(SPF)

CONDITION 5
(100 YR)
(SPF)

SCALE
0 250 500 FEET

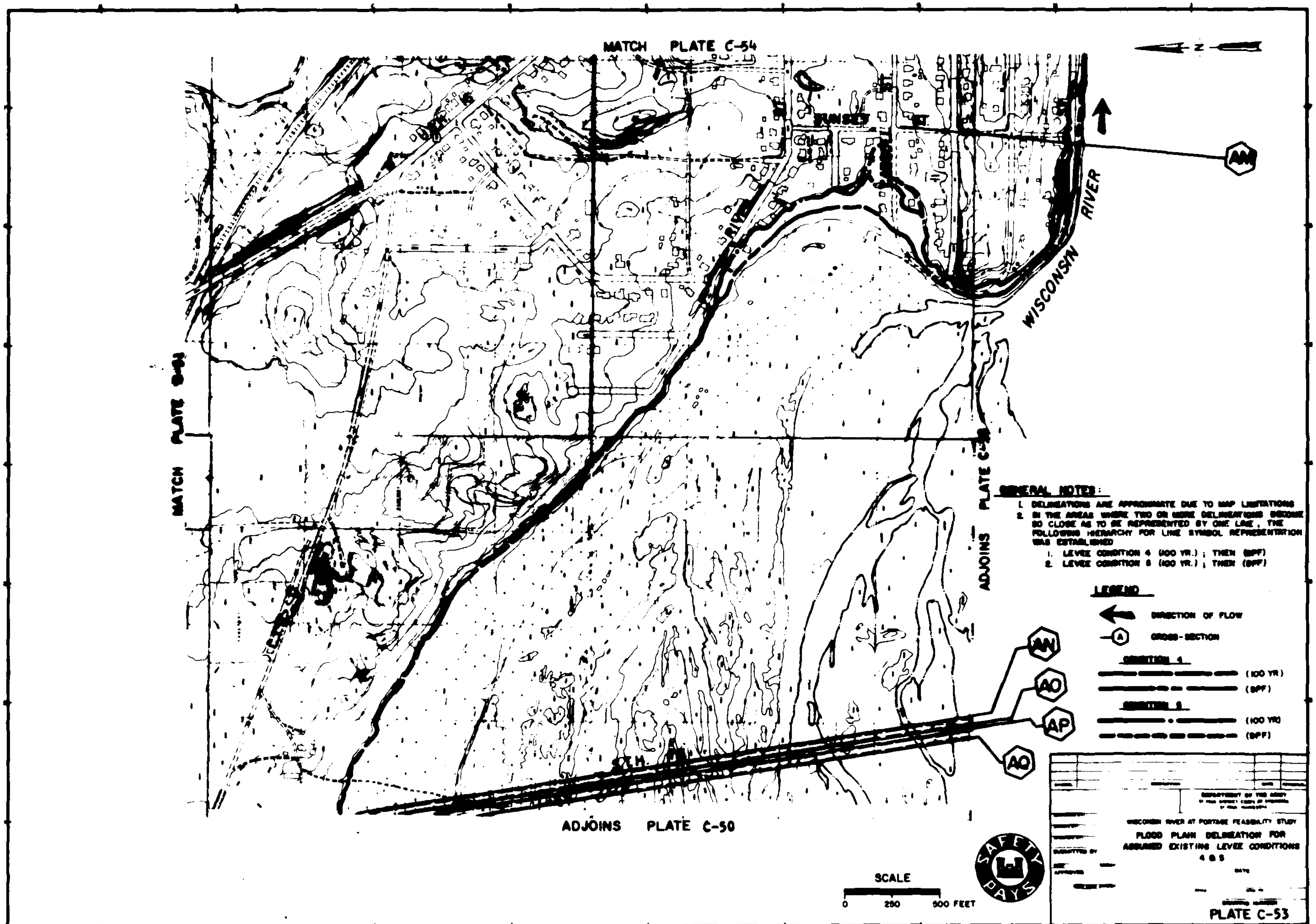
SAFETY PAYS

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS

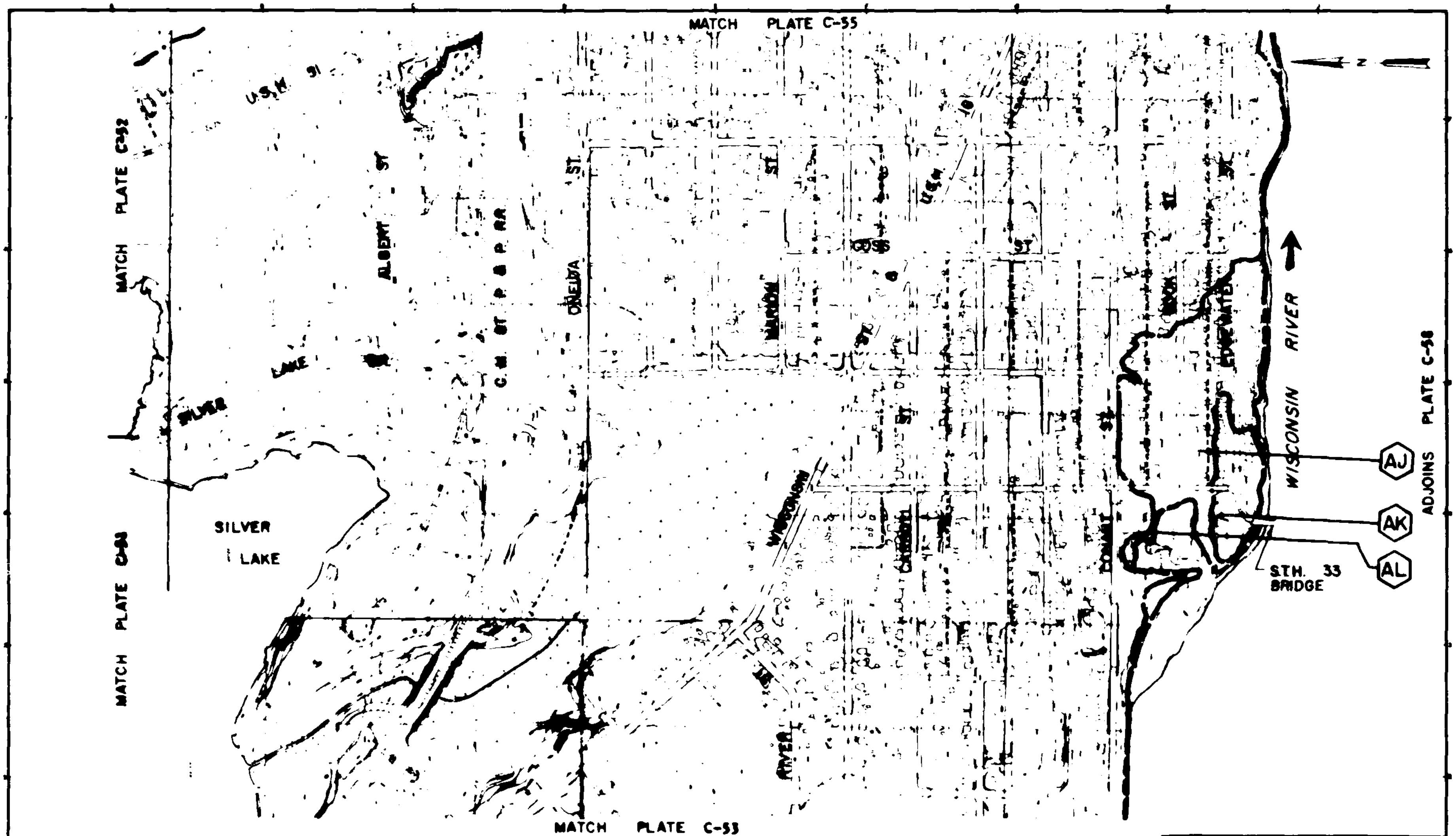
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

PLATE C-52



MATCH PLATE C-54
MATCH PLATE B-51
ADJOINS PLATE C-50
ADJOINS PLATE C-52
N
WISCONSIN RIVER
SUNSET ST.
AN
AO
AP
GENERAL NOTES:
1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
1. LEVEE CONDITION 4 (100 YR.) ; THEN (SPF)
2. LEVEE CONDITION 5 (100 YR.) ; THEN (SPF)
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 4
(100 YR)
(SPF)
CONDITION 5
(100 YR)
(SPF)
SCALE
0 250 500 FEET
SAFETY PAYS
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5
PLATE C-53



GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS.
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR), THEN (SPF)

LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 4

(100 YR)

(SPF)

CONDITION 5

(100 YR)

(SPF)

SCALE

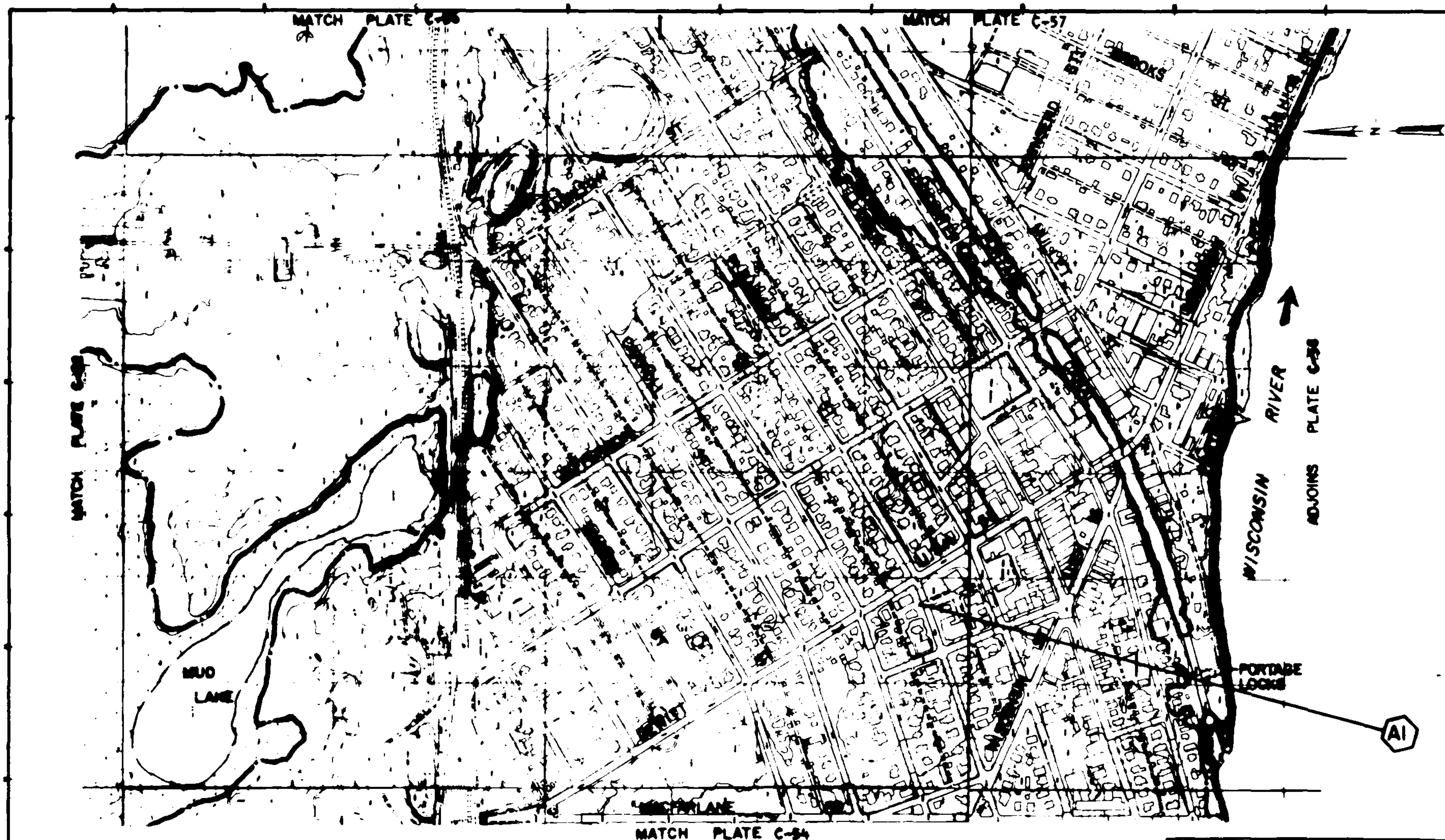
0 250 500 FEET

SAFETY PAYS

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

PLATE C-54



LEGEND

DIRECTION OF FLOW

CROSS-SECTION

CONDITION 4

(100 YR)

(SPF)

CONDITION 5

(100 YR)

(SPF)

GENERAL NOTES:

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR), THEN (SPF)

SCALE

0 250 500 FEET

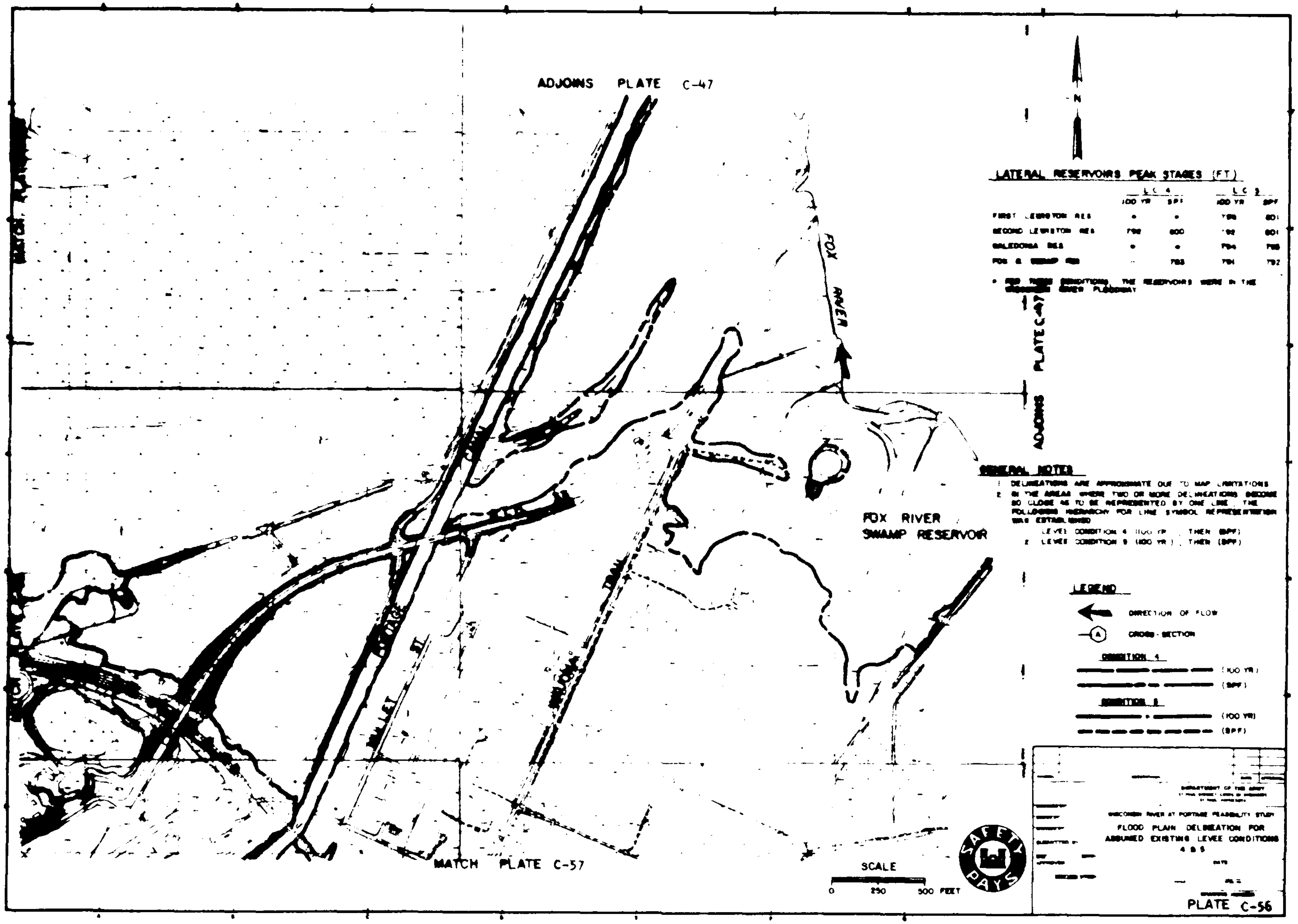
SAFETY PAYS

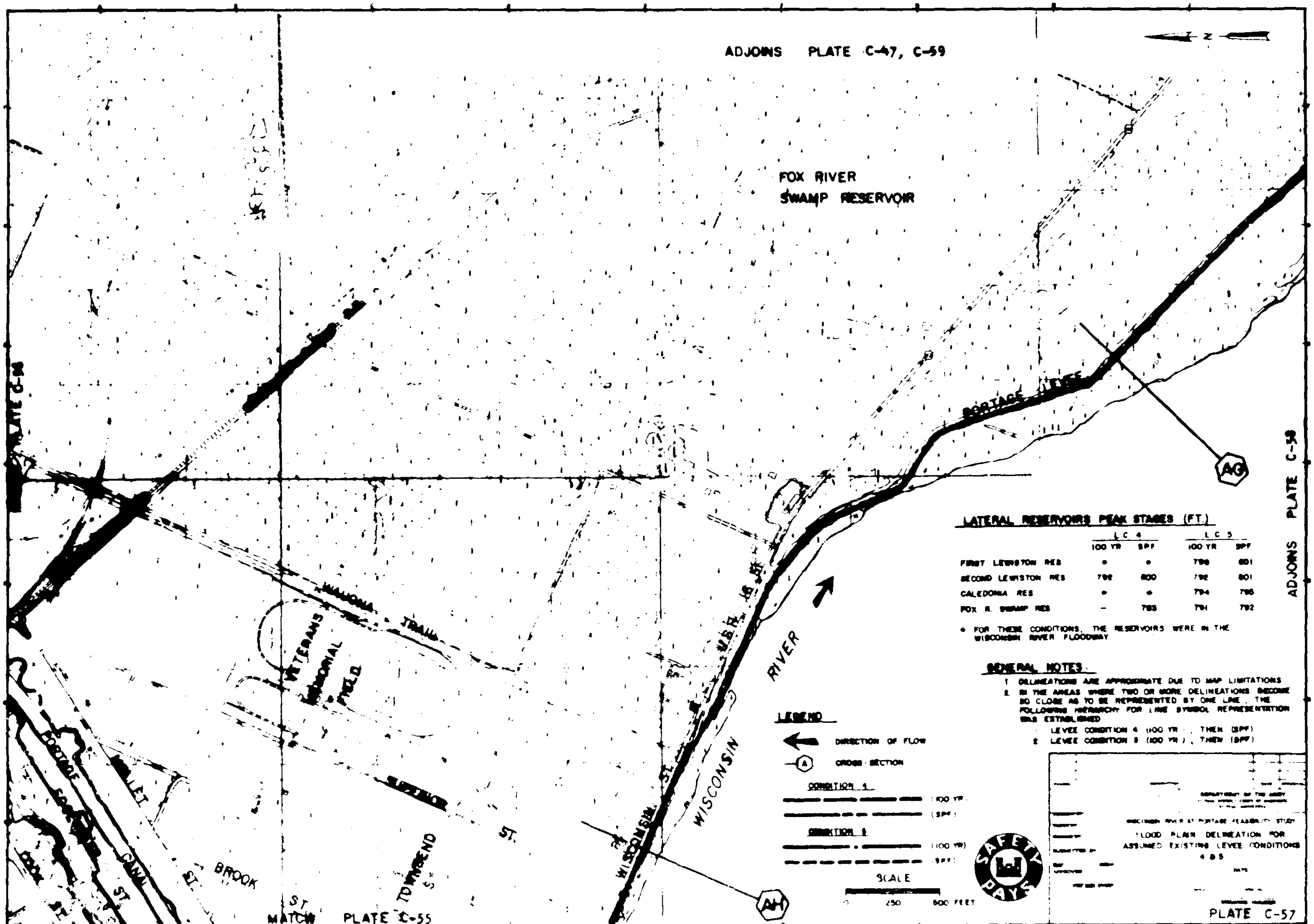
DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

PLATE C-55


ADJOINS PLATE C-47
N
LATERAL RESERVOIRS PEAK STAGES (FT)
L C 4
L C 2
100 YR
SPF
FIRST LEWISTON RES
SECOND LEWISTON RES
CALEDONIA RES
FOX RIVER
FOX RIVER SWAMP RESERVOIR
ADJOINS PLATE C-47
GENERAL NOTES
1 DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2 IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
LEVEE CONDITION 4 (100 YR), THEN (SPF)
2 LEVEE CONDITION 5 (100 YR), THEN (SPF)
LEGEND
DIRECTION OF FLOW
CROSS-SECTION
CONDITION 4
(100 YR)
(SPF)
CONDITION 5
(100 YR)
(SPF)
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS
4 & 5
MATCH PLATE C-57
SCALE
0 250 500 FEET
SAFETY PAYS
PLATE C-56



LATERAL RESERVOIRS PEAK STAGES (FT.)

	L C 4		L C 5	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	*	*	796	801
SECOND LEWISTON RES	792	800	792	801
CALEDONIA RES	*	*	794	796
FOX R. SWAMP RES	–	793	791	792

* FOR THESE CONDITIONS, THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

GENERAL NOTES:

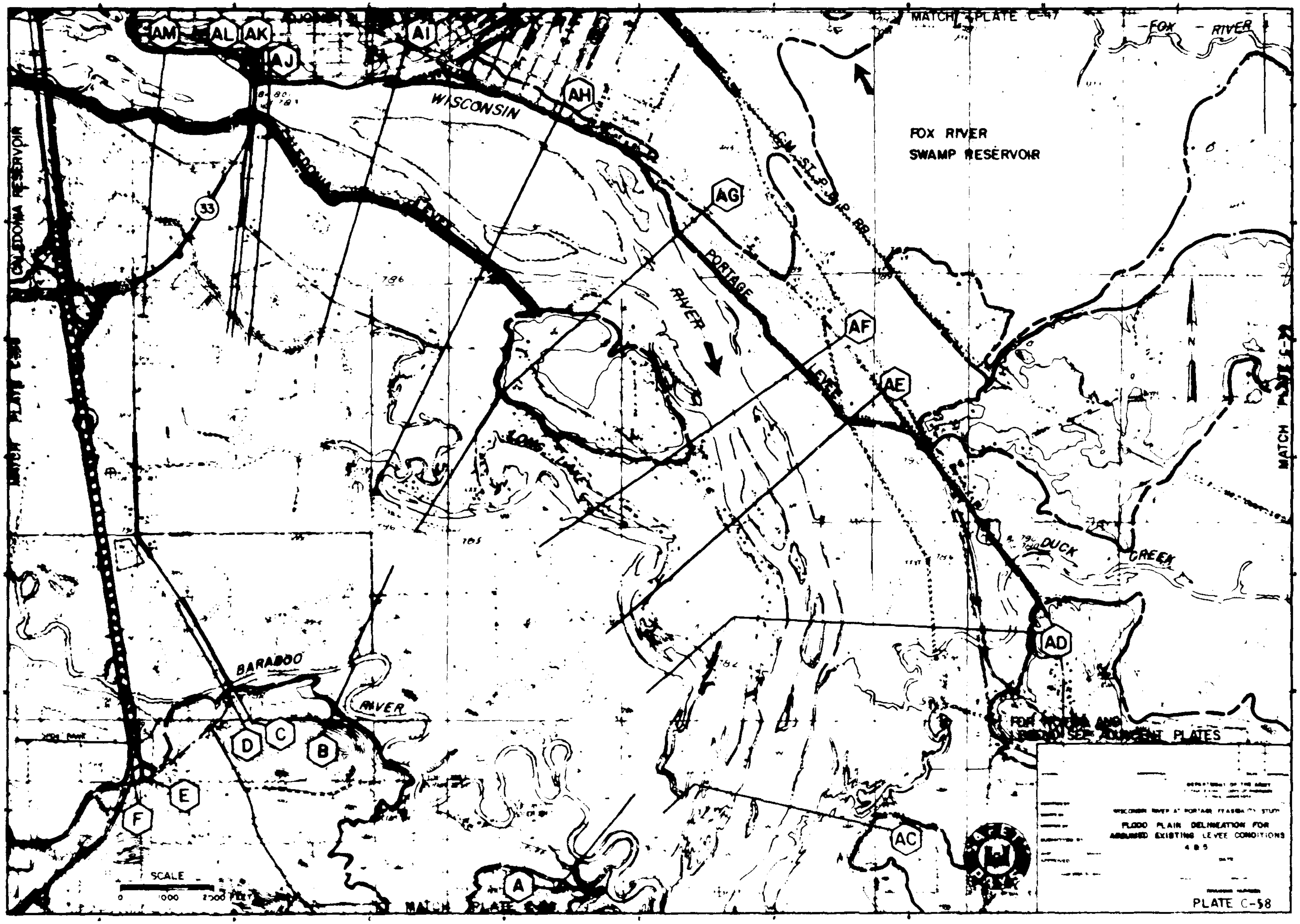
1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR), THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR), THEN (SPF)

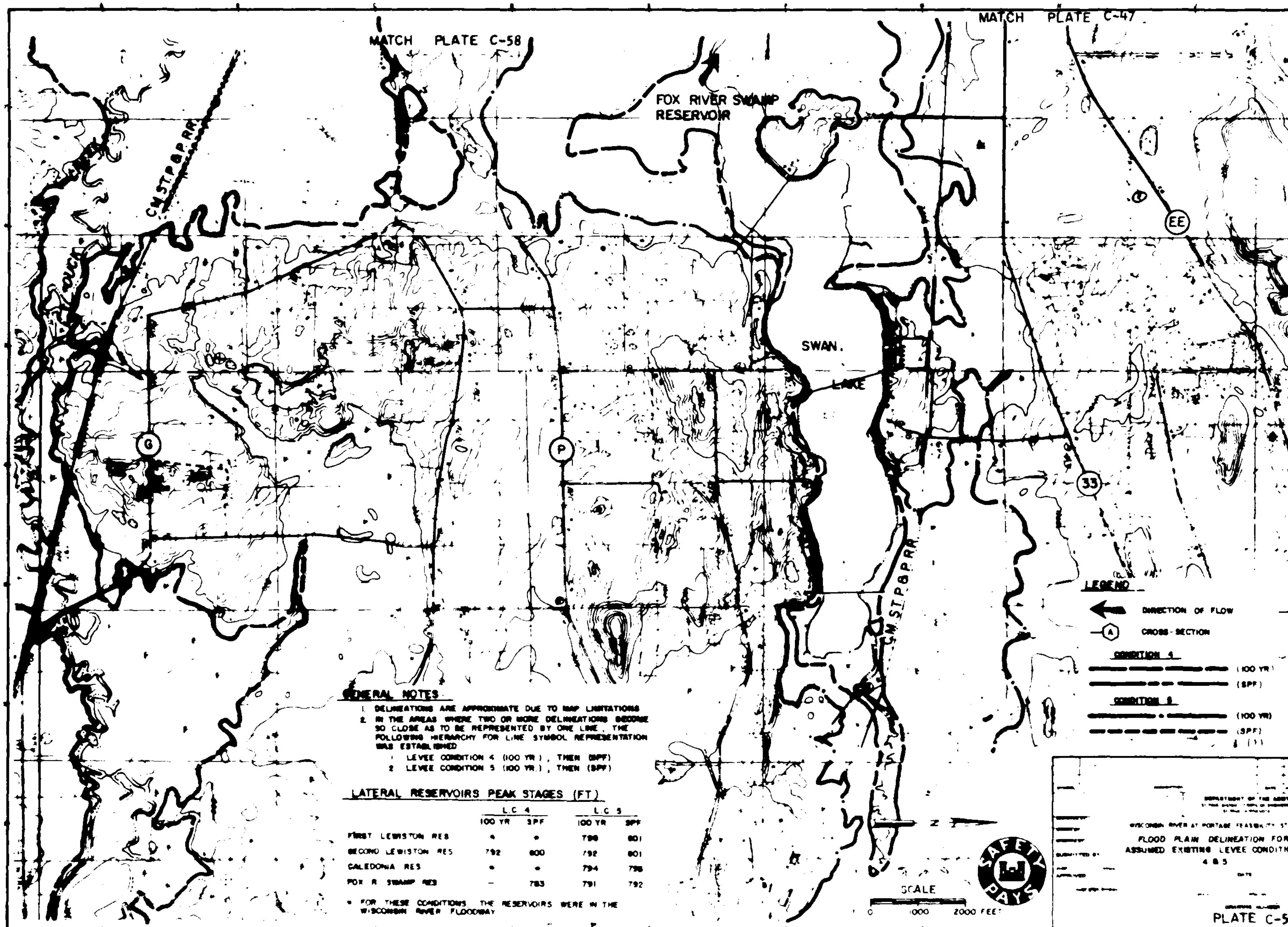
DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

PLATE C-57


MATCH PLATE C-47
FOX RIVER
FOX RIVER
SWAMP RESERVOIR
C.M. ST. P. & P. RR
WISCONSIN
PORTAGE
RIVER
LEVEE
LONG LAKE
DUCK
CREEK
BARABOO
RIVER
CALEDONIA RESERVOIR
AM
AL
AK
AJ
AI
AH
AG
AF
AE
AD
AC
A
B
C
D
E
F
33
N
SCALE
0
1000
2000 FEET
MATCH PLATE
FOR PROFILE AND
SEE ADJACENT PLATES
FLOOD PLAIN DELINEATION FOR
EXISTING LEVEE CONDITIONS
PLATE C-58



GENERAL NOTES

1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
   1. LEVEE CONDITION 4 (100 YR.), THEN (SPF)
   2. LEVEE CONDITION 5 (100 YR.), THEN (SPF)

LATERAL RESERVOIRS PEAK STAGES (FT)

	L.C 4		L.C 5	
	100 YR	SPF	100 YR	SPF
FIRST LEWISTON RES	*	*	799	801
SECOND LEWISTON RES	792	800	792	801
CALEDONIA RES	*	*	794	795
FOX R. SWAMP RES	—	783	791	792

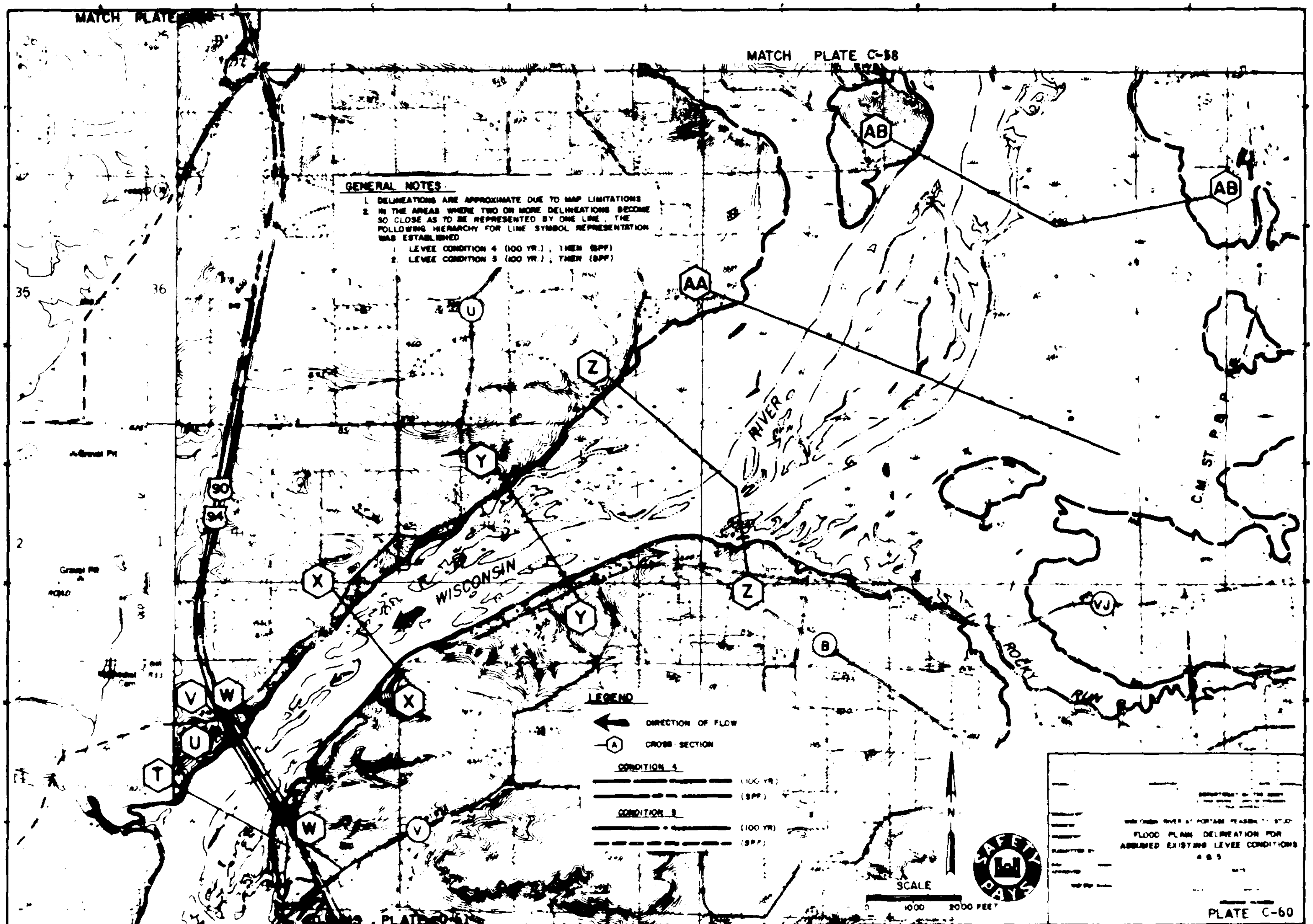
* FOR THESE CONDITIONS THE RESERVOIRS WERE IN THE WISCONSIN RIVER FLOODWAY

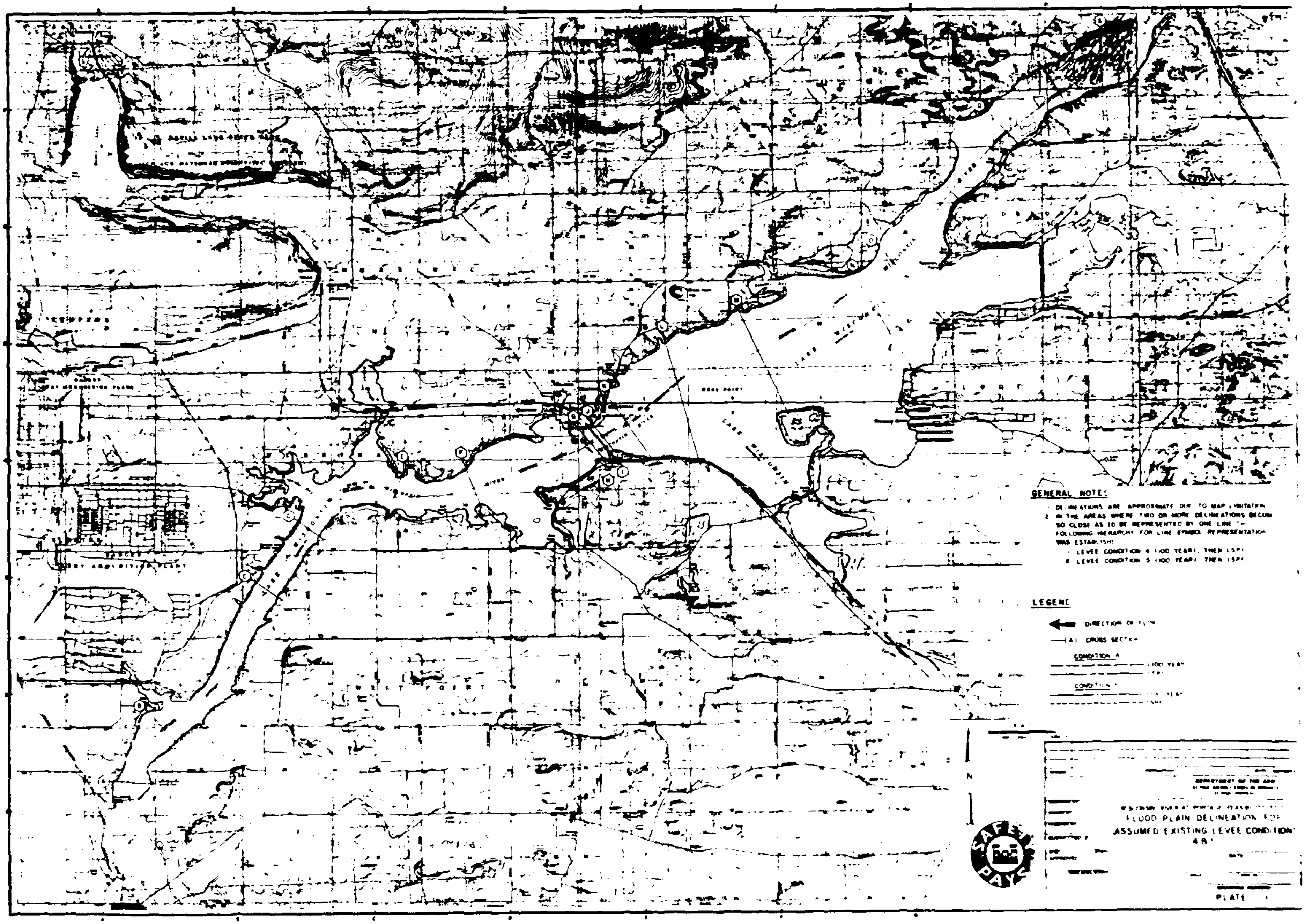
DEPARTMENT OF THE ARMY

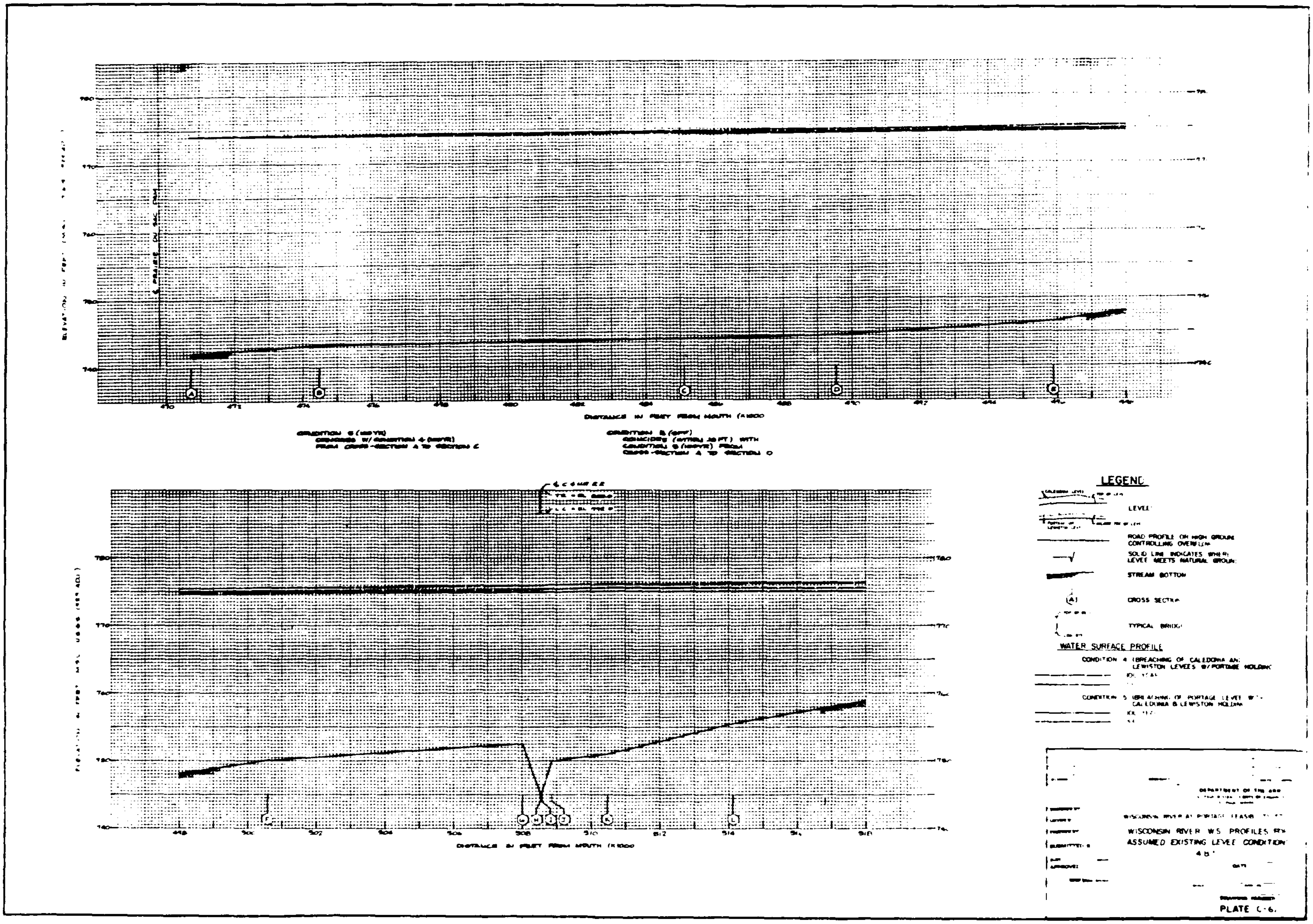
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

FLOOD PLAIN DELINEATION FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

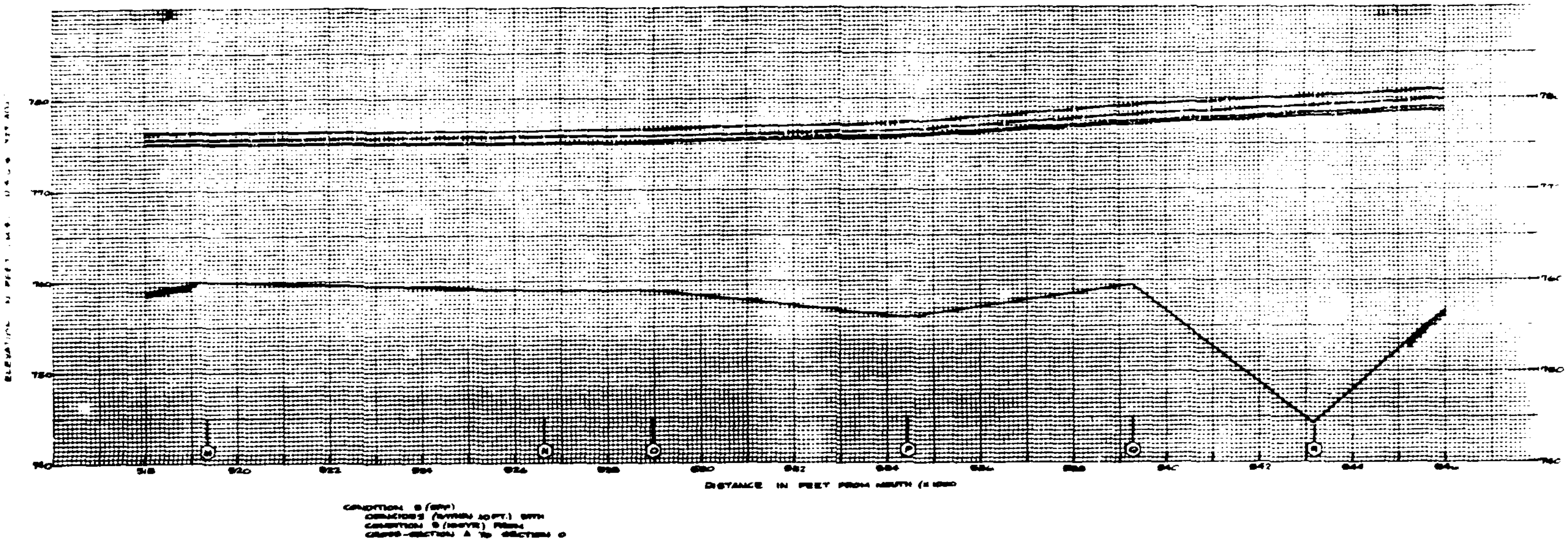
PLATE C-59

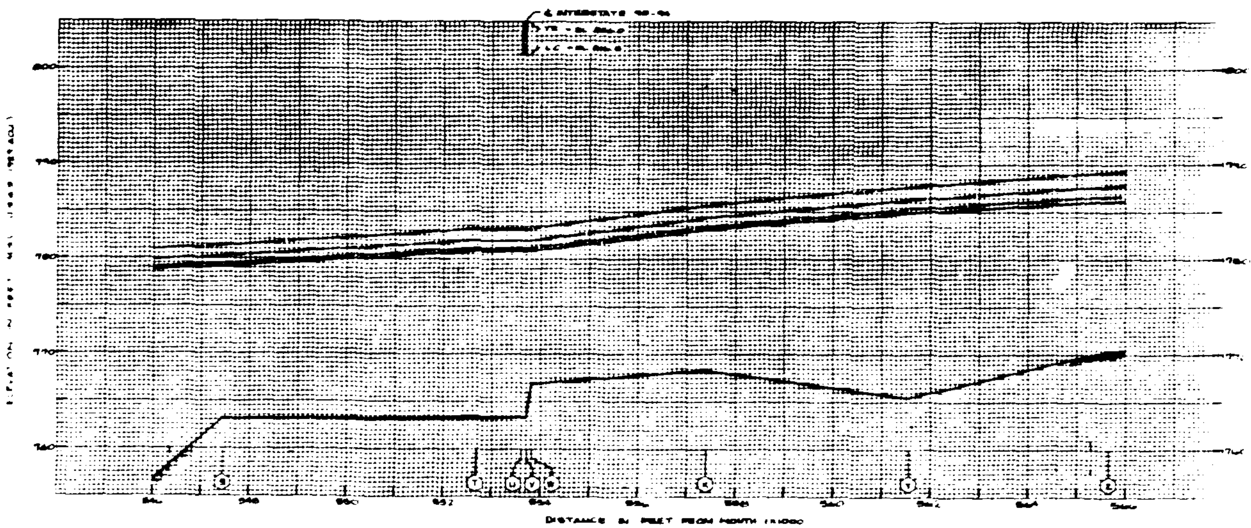

MATCH PLATE C-58
GENERAL NOTES
1. DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATIONS
2. IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOME SO CLOSE AS TO BE REPRESENTED BY ONE LINE, THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
1. LEVEE CONDITION 4 (100 YR.), THEN (SPF)
2. LEVEE CONDITION 5 (100 YR.), THEN (SPF)
LEGEND
DIRECTION OF FLOW
CROSS SECTION
CONDITION 4
(100 YR)
(SPF)
CONDITION 5
(100 YR)
(SPF)
WISCONSIN
RIVER
ROCKY RUN
C M ST P & P
SCALE
0 1000 2000 FEET
N
SAFETY PAYS
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
4 & 5
PLATE C-60


GENERAL NOTES:
1 DELINEATIONS ARE APPROXIMATE DUE TO MAP LIMITATION
2 IN THE AREAS WHERE TWO OR MORE DELINEATIONS BECOM SO CLOSE AS TO BE REPRESENTED BY ONE LINE THE FOLLOWING HIERARCHY FOR LINE SYMBOL REPRESENTATION WAS ESTABLISHED
1 LEVEE CONDITION 4 (100 YEAR), THEN (SPF)
2 LEVEE CONDITION 5 (100 YEAR), THEN (SPF)
LEGEND
DIRECTION OF FLOW
CROSS SECTION
CONDITION 4
100 YEAR
CONDITION
FLOOD PLAIN DELINEATION FOR
ASSUMED EXISTING LEVEE CONDITIONS
LAKE WISCONSIN
WEST POINT
PLATE



DISTANCE IN FEET FROM MOUTH (X1000)
LEGEND
LEVEE
ROAD PROFILE OR HIGH GROUND CONTROLLING OVERFLOW
SOLID LINE INDICATES WHERE LEVEE MEETS NATURAL GROUND
STREAM BOTTOM
CROSS SECTION
TYPICAL BRIDGE
WATER SURFACE PROFILE
CONDITION 4 (BREACHING OF CALEDONIA AND LEWISTON LEVEES W/PORTAGE HOLDING)
CONDITION 5 (BREACHING OF PORTAGE LEVEE WITH CALEDONIA & LEWISTON HOLDING)
DEPARTMENT OF THE ARMY
WISCONSIN RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITION
PLATE C-6.





LEGEND

LEVEE

ROAD PROFILE OR HIGH GROUND CONTROLLING OVERFLOW

SOLID LINE INDICATES WHERE LEVEE MEETS NATURAL GROUND

STREAM BOTTOM

CROSS-SECTION

TYPICAL BRIDGE

WATER SURFACE PROFILES

CONDITION 4 (BREACHING OF CALEDONIA AND LEWISTON LEVEES W/PORTAGE HOLDING)

100 YEAR

SPF

CONDITION 5 (BREACHING OF PORTAGE LEVEE WITH CALEDONIA & LEWISTON HOLDING)

100 YEAR

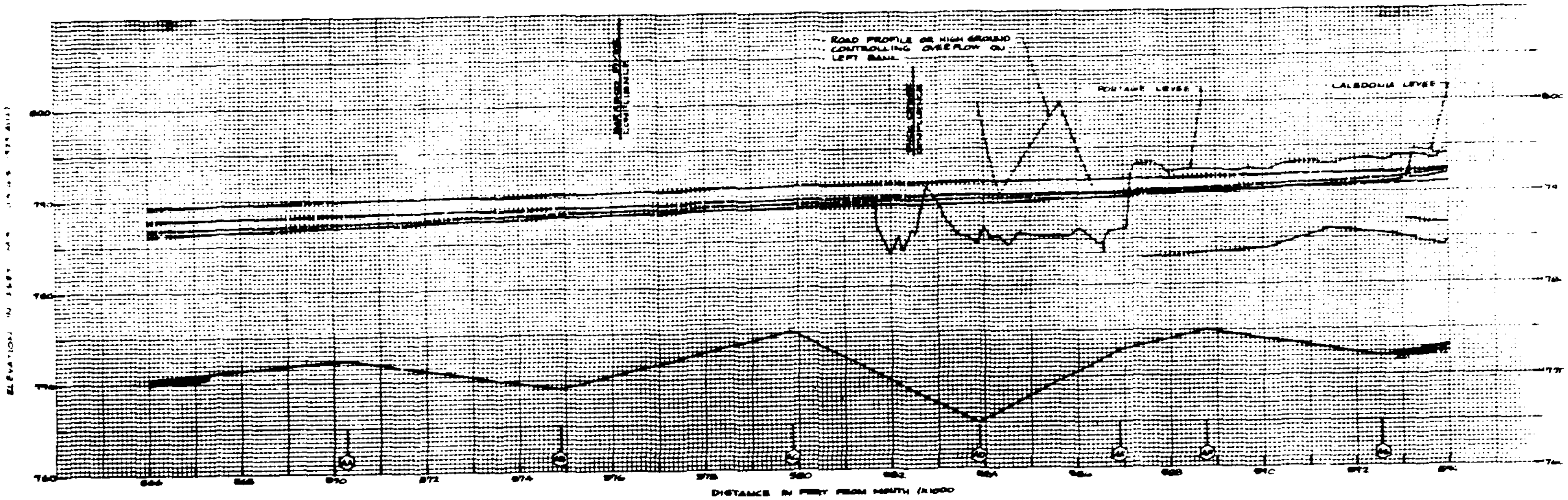
SPF

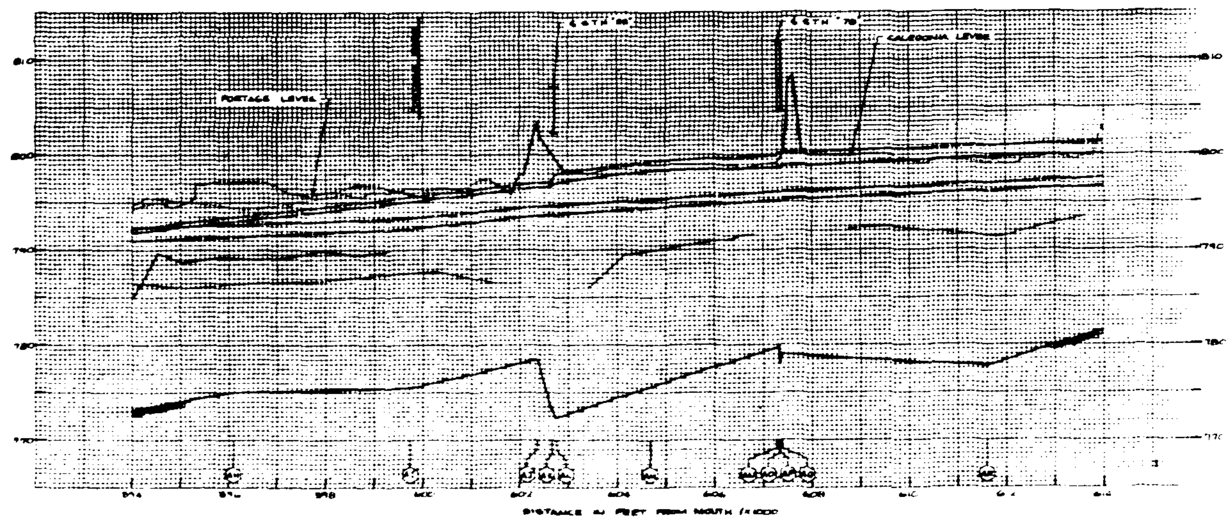
DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

WISCONSIN RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITION 4 & 5

PLATE C-6?





LEGEND

LEVEE

ROAD PROFILE OR HIGH GROUND CONTROLLING OVERFLOW

SOLID LINE INDICATES WHERE LEVEE MEETS NATURAL GROUND

STREAM BOTTOM

CROSS SECTION

TYPICAL BRIDGE

WATER SURFACE PROFILE

CONDITION 4 (BREACHING OF CALEDONIA AND LEWISTON LEVEES W/ PORTAGE HOLDING)

100 YEAR

CONDITION 5 (BREACHING OF PORTAGE LEVEE WITH CALEDONIA & LEWISTON HOLDING)

100 YEAR

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

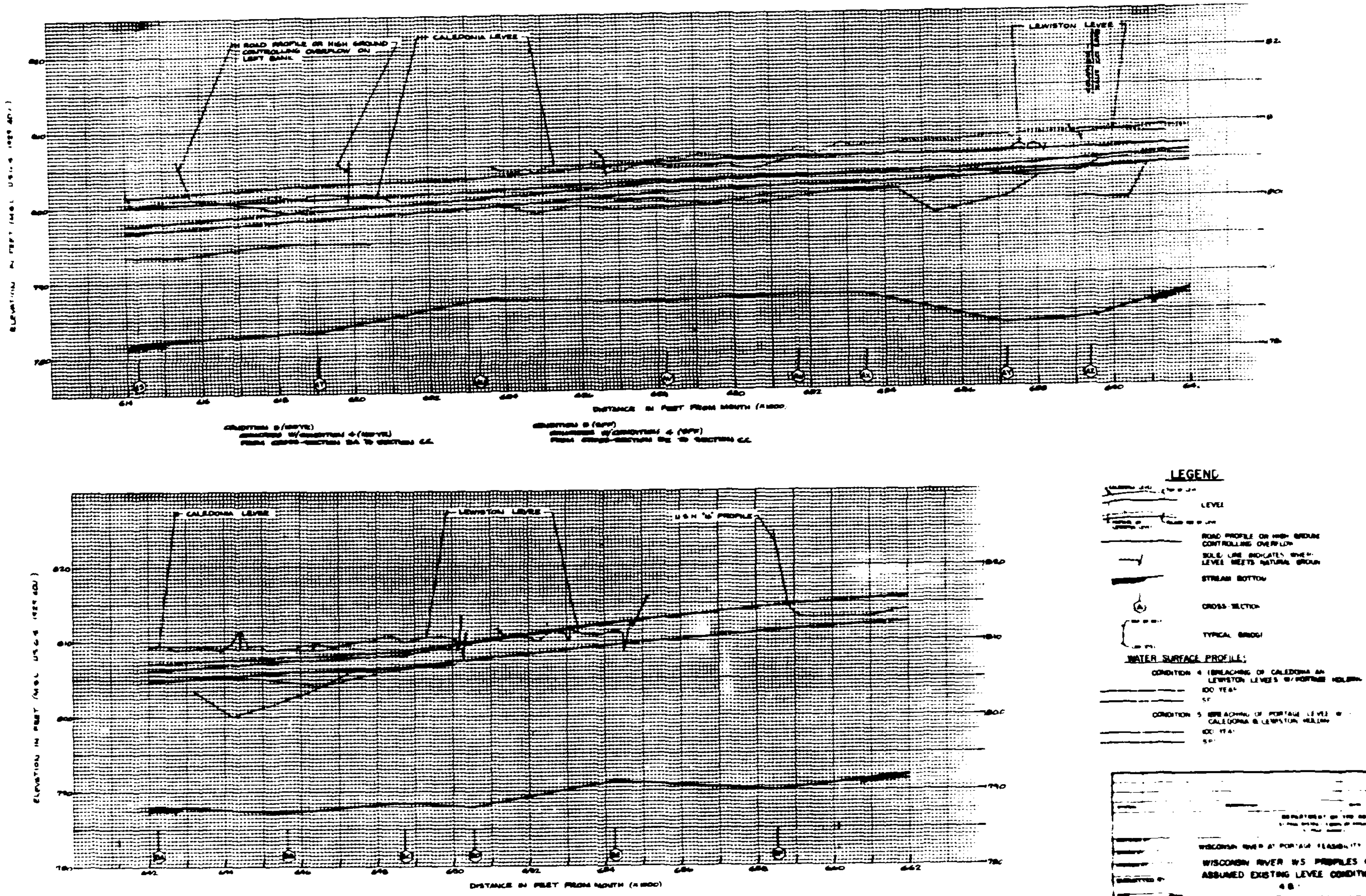
WISCONSIN RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

SUBMITTED BY

APPROVED

DATE

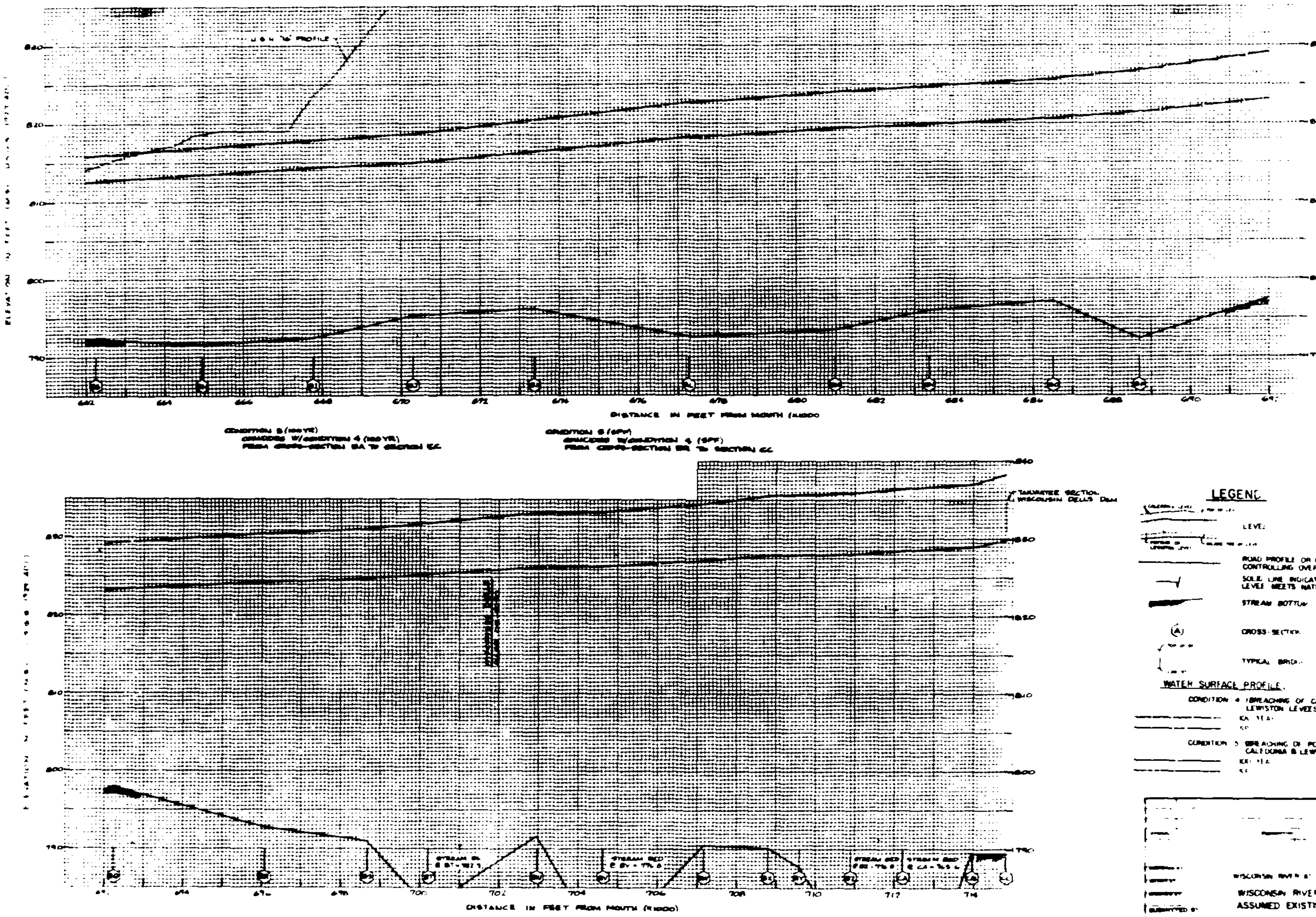
PLATE C 6-



WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

WISCONSIN RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

PLATE C-6



LEGEND

LEVEE

ROAD PROFILE OR HIGH GROUND CONTROLLING OVERFLOW

SOLID LINE INDICATES WHERE LEVEE MEETS NATURAL GROUND

STREAM BOTTOM

CROSS-SECTION

TYPICAL BRIDGE

WATER SURFACE PROFILE

CONDITION 4 (BREACHING OF CALEDONIA AND LEWISTON LEVEES W/ PORTAGE HOLDING)

CONDITION 5 (BREACHING OF PORTAGE LEVEE W/ CALEDONIA & LEWISTON HOLDING)

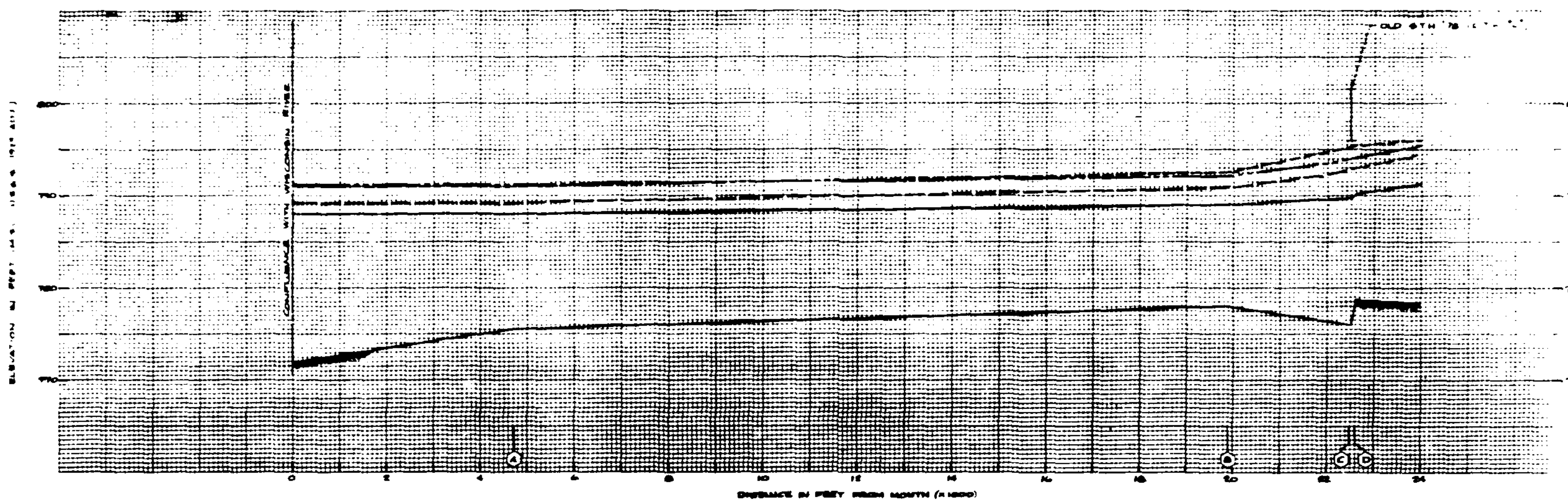
DEPARTMENT OF THE ARMY

WISCONSIN RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

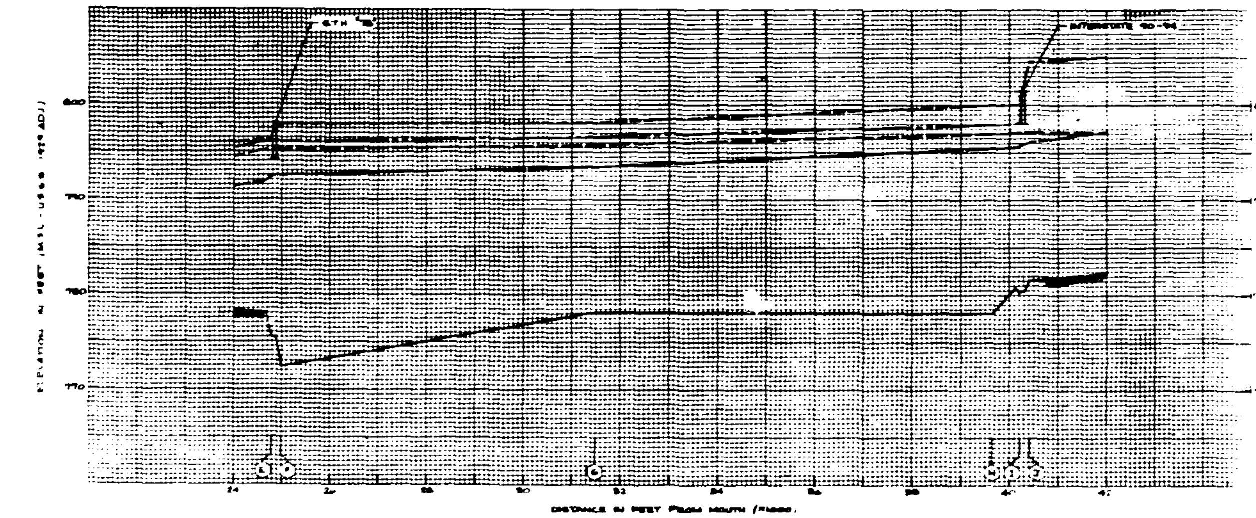
SUBMITTED BY:

APPROVED:

PLATE C-64



CONDITION 5 (SPF) COINCIDES WITH CONDITION 4 SPF
FROM CROSS SECTION 1 TO CROSS SECTION U



LEGEND

STREAM BOTTOM

CROSS SECTION

TYPICAL BRIDGE

WATER SURFACE PROFILE:

CONDITION 4 (BREACHING OF CALEDONIA AND LEWISTON LEVEES W/PORTAGE HOLDING)
100 YEAR
SPF

CONDITION 5 (BREACHING OF PORTAGE LEVEE WITH CALEDONIA & LEWISTON HOLDING)
100 YEAR
SPF

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

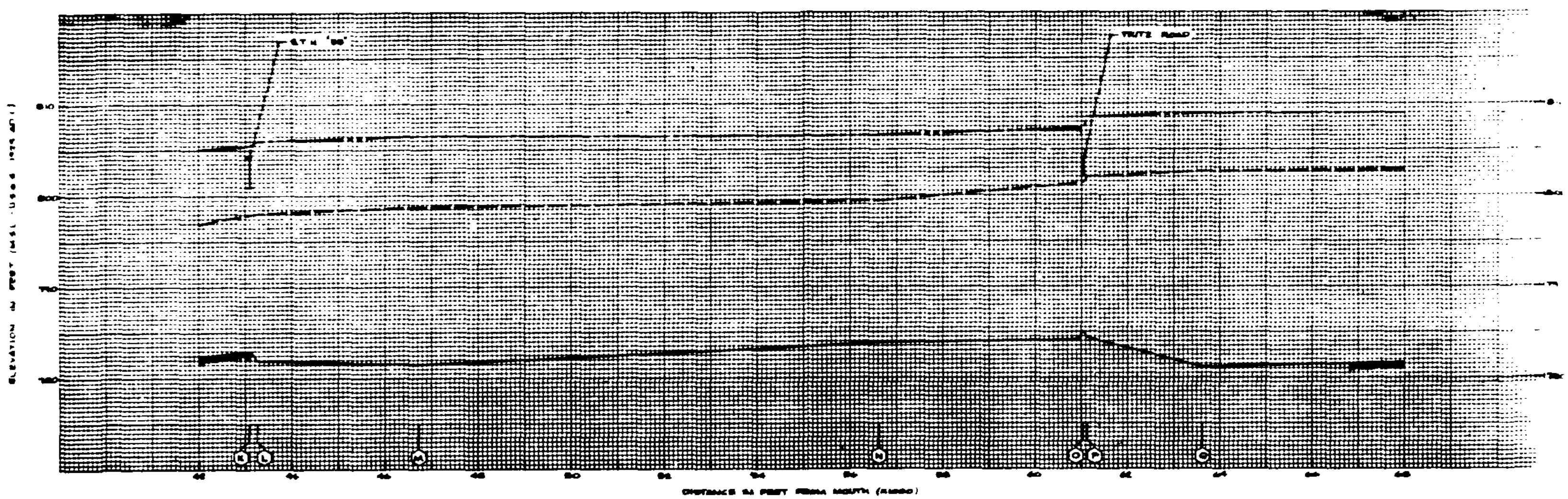
BARABOO RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITION 4 & 5

SUBMITTED BY

APPROVED

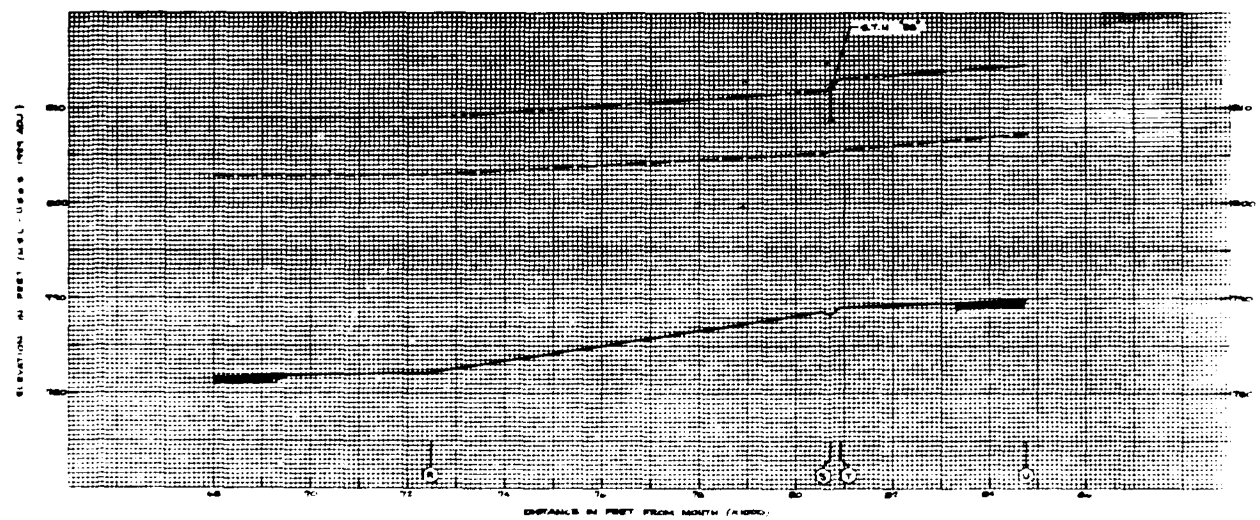
DATE

PLATE C-6



CONDITION 8 (100 YR) COINCIDES WITH CONDITION 5 (100 YR) FROM STATION 52 TO CROSS SECTION U

CONDITION 4 (SPF) COINCIDES WITH CONDITION 5 (SPF) FROM CROSS SECTION 1 TO CROSS SECTION U



LEGEND:

STREAM BOTTOM

CROSS SECTION

TYPICAL BRIDGE

WATER SURFACE PROFILE

CONDITION 4 (BREACHING OF CALEDONIA AND LEWISTON LEVEES W/ PORTAGE HOLDING)

CONDITION 5 (BREACHING OF PORTAGE LEVEE W/ CALEDONIA & LEWISTON HOLDING)

DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

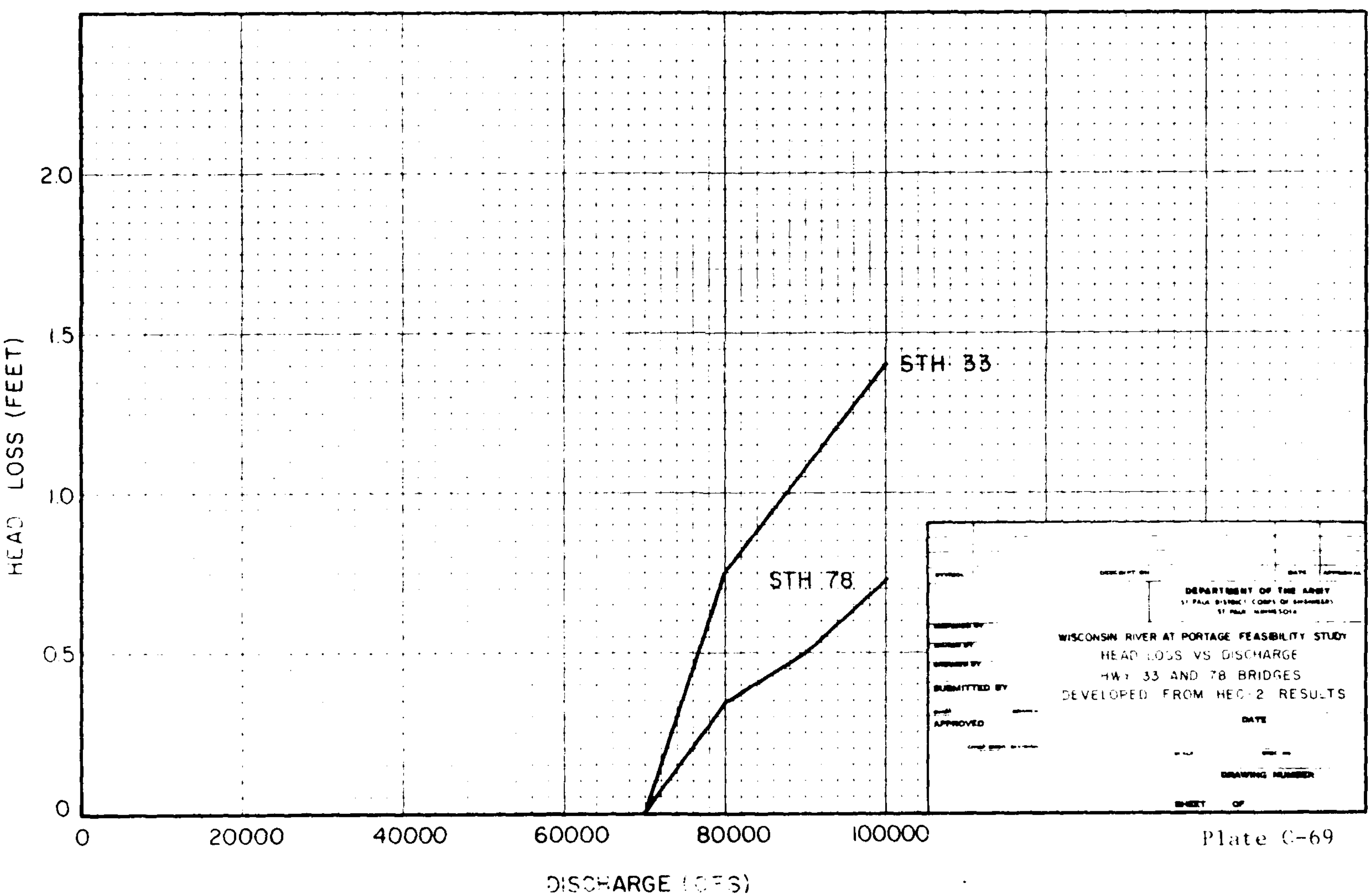
BARABOO RIVER W.S. PROFILES FOR ASSUMED EXISTING LEVEE CONDITIONS 4 & 5

SUBMITTED BY

APPROVED

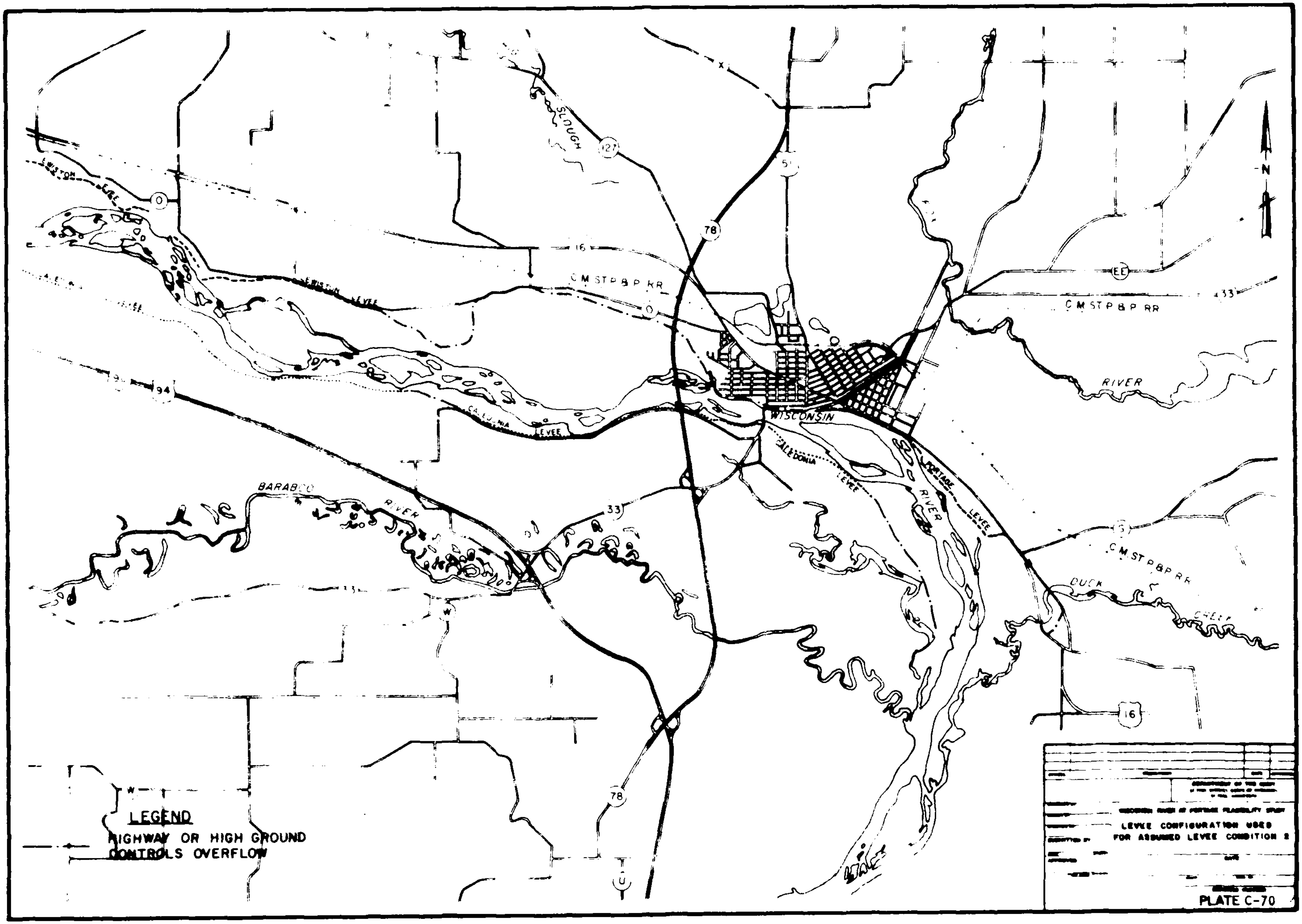
DATE

PLATE C-68

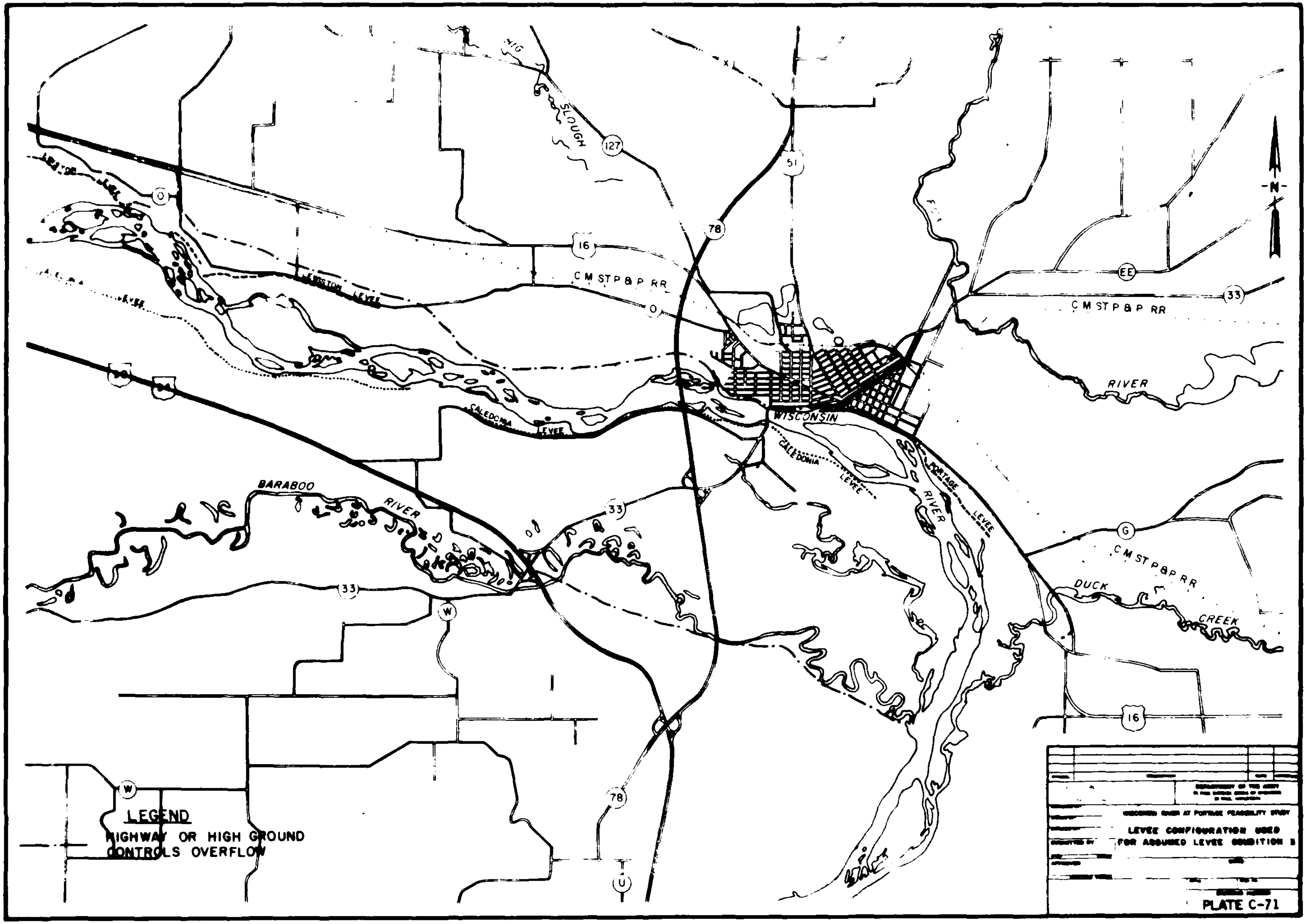


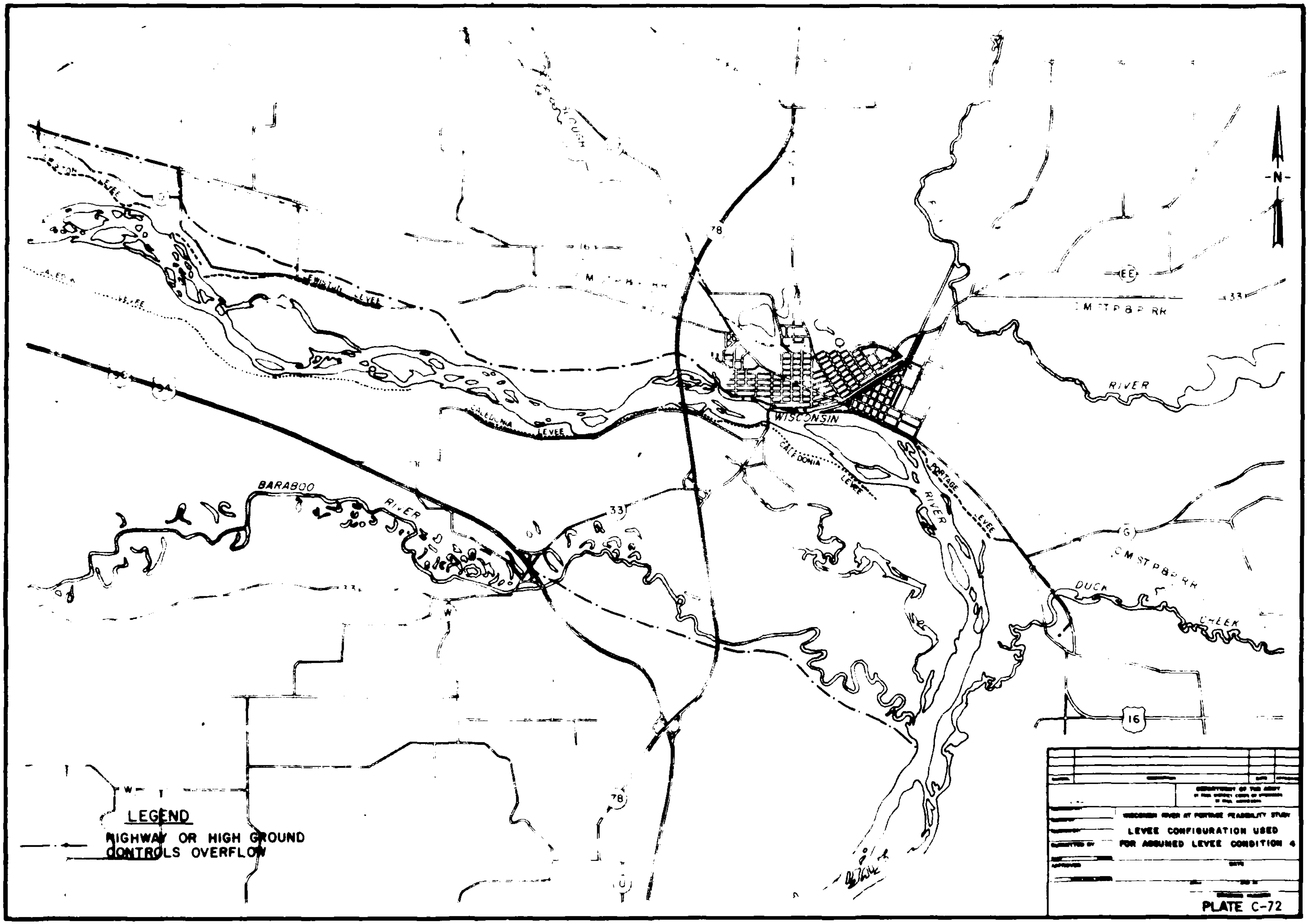
STH 33
STH 78
HEAD LOSS (FEET)
DISCHARGE (CFS)
0
0.5
1.0
1.5
2.0
20000
40000
60000
80000
100000
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
HEAD LOSS VS DISCHARGE
HWY 33 AND 78 BRIDGES
DEVELOPED FROM HEC-2 RESULTS
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

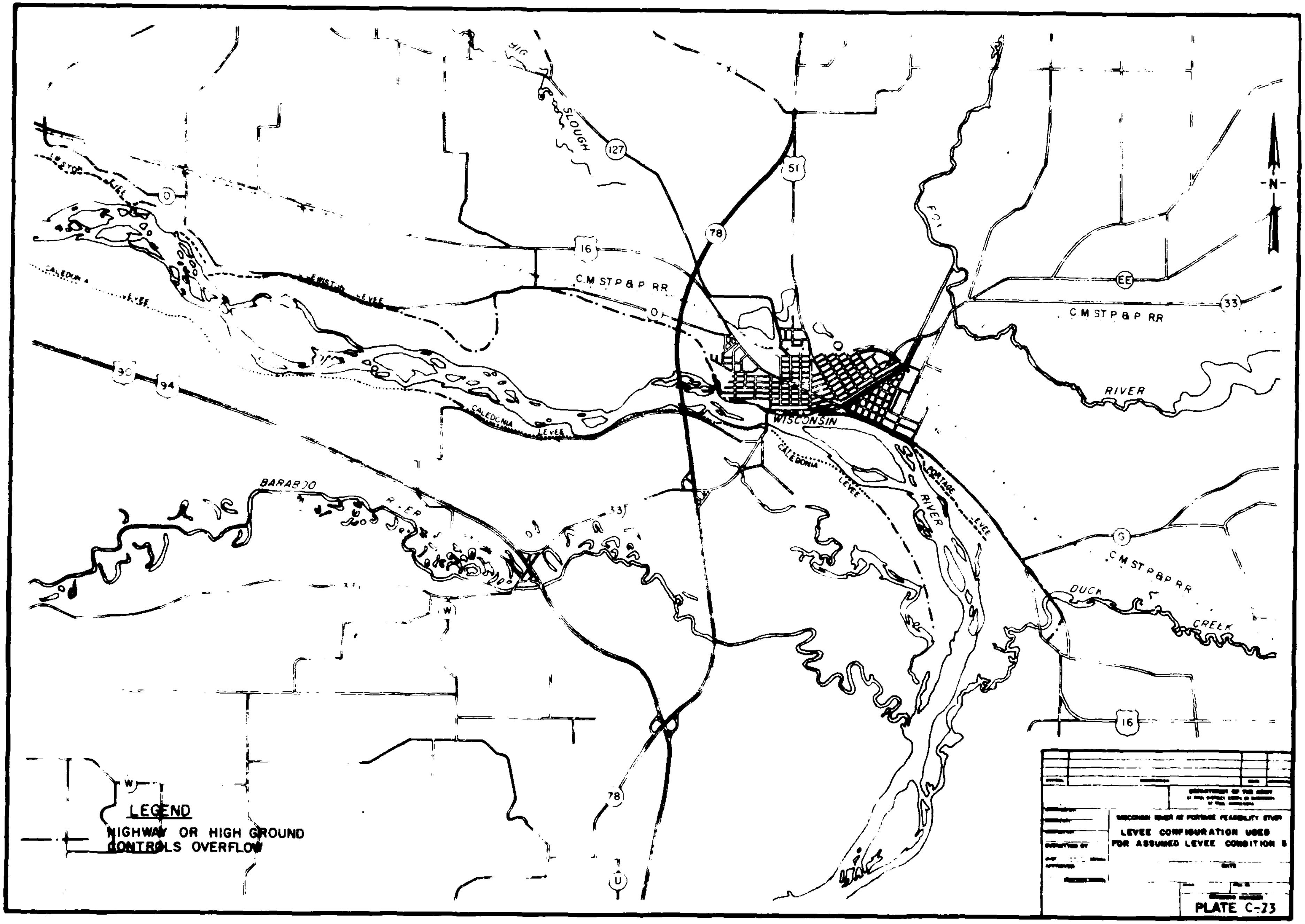
Plate C-69



N
SLOUGH
127
51
78
16
C M ST P & P RR
LEWISTON LEVEE
CALEDONIA LEVEE
94
WISCONSIN
RIVER
PORTAGE LEVEE
BARABOO
33
EE
33
5
DUCK
CREEK
W
U
LEGEND
HIGHWAY OR HIGH GROUND CONTROLS OVERFLOW
LEVEE CONFIGURATION USED FOR ASSUMED LEVEE CONDITION 2
PLATE C-70


N
SLOUGH
127
51
78
16
O
CMSTP&P RR
LEWISTON LEVEE
EE
33
FOX
RIVER
WISCONSIN
CALEDONIA LEVEE
CALEDONIA LEVEE
PORTAGE LEVEE
RIVER
G
CMSTP&P RR
DUCK CREEK
BARABOO RIVER
33
W
U
LEGEND
HIGHWAY OR HIGH GROUND CONTROLS OVERFLOW
LEVEE CONFIGURATION USED
PLATE C-71


N
WISCONSIN
RIVER
PORTAGE LEVEE
CALEDONIA LEVEE
CALEDONIA LEVEE
LEWISTON LEVEE
BARABOO
RIVER
DUCK CREEK
C M ST P & P RR
C M ST P & P RR
78
33
16
EE
G
LEGEND
HIGHWAY OR HIGH GROUND CONTROLS OVERFLOW
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
LEVEE CONFIGURATION USED FOR ASSUMED LEVEE CONDITION 4
PLATE C-72


N
BIG SLOUGH
127
51
78
16
C M ST P & P RR
33
EE
FOX
RIVER
WISCONSIN
RIVER
PORTAGE LEVEE
CALEDONIA LEVEE
LEWISTON LEVEE
90
94
BARABOO RIVER
G
DUCK CREEK
W
U
O
LEGEND
HIGHWAY OR HIGH GROUND CONTROLS OVERFLOW
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
LEVEE CONFIGURATION USED FOR ASSUMED LEVEE CONDITION 5
PLATE C-23

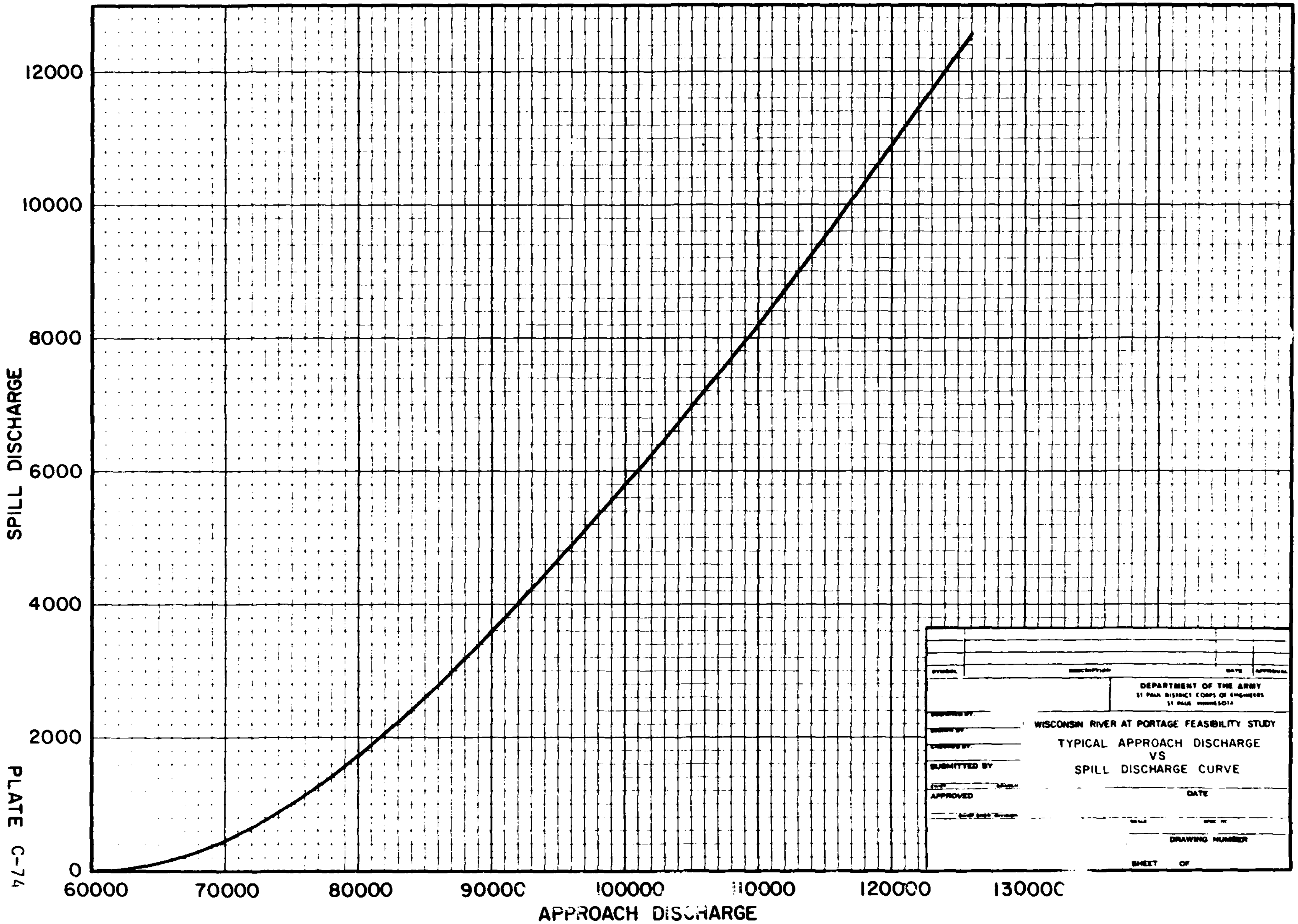

SPILL DISCHARGE
APPROACH DISCHARGE
0
2000
4000
6000
8000
10000
12000
60000
70000
80000
90000
100000
110000
120000
130000
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
TYPICAL APPROACH DISCHARGE
VS
SPILL DISCHARGE CURVE
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER
SHEET OF

PLATE C-74

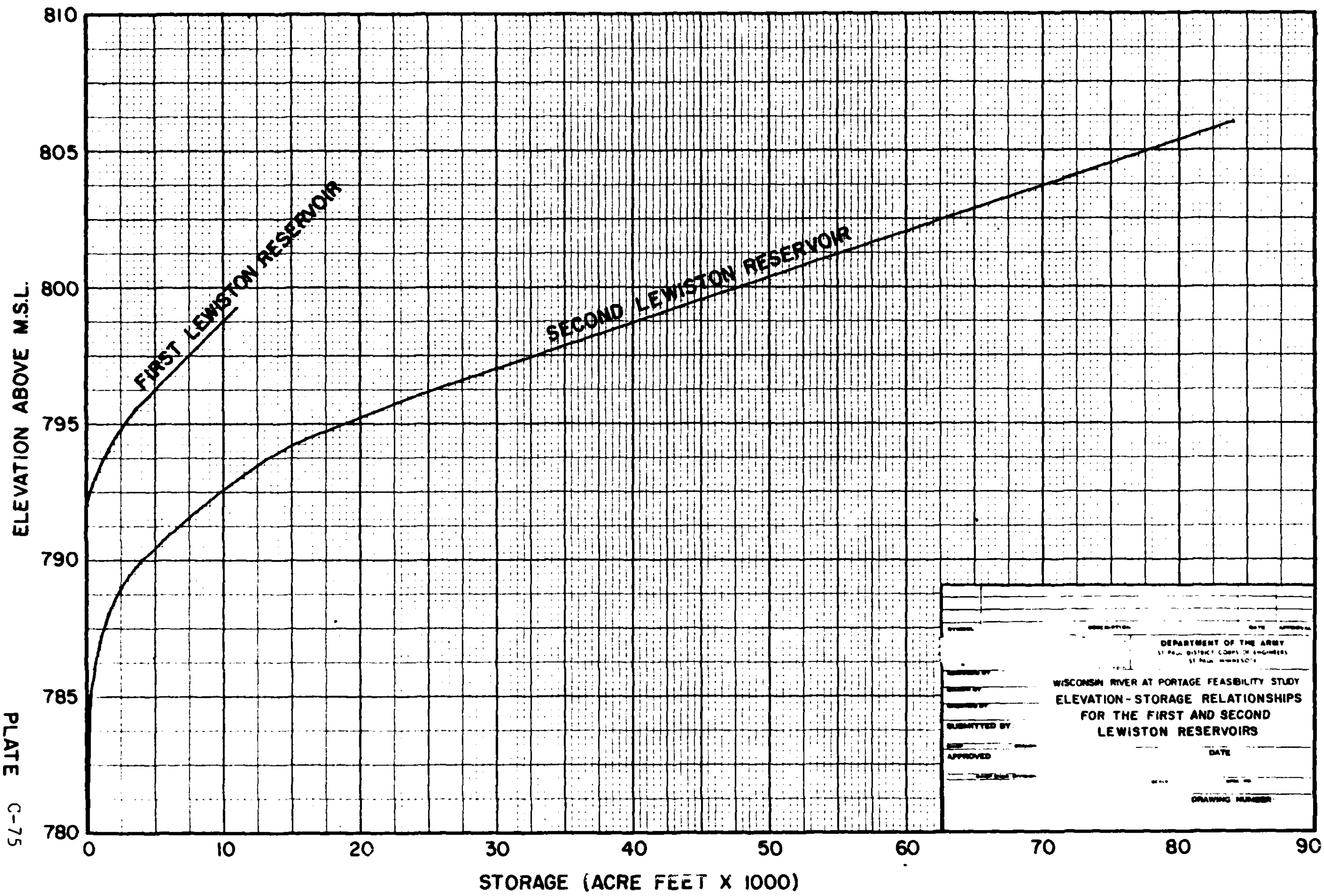
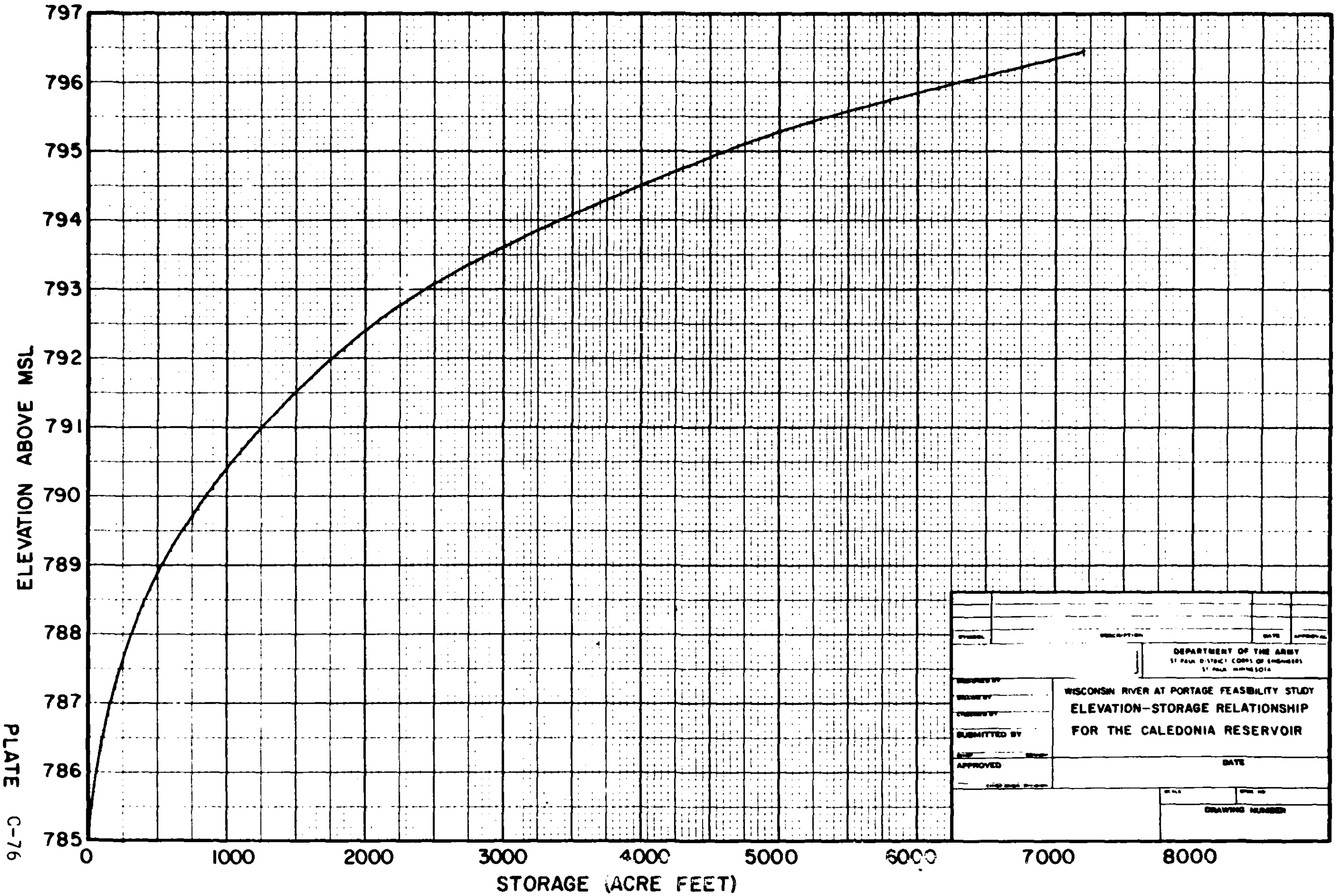
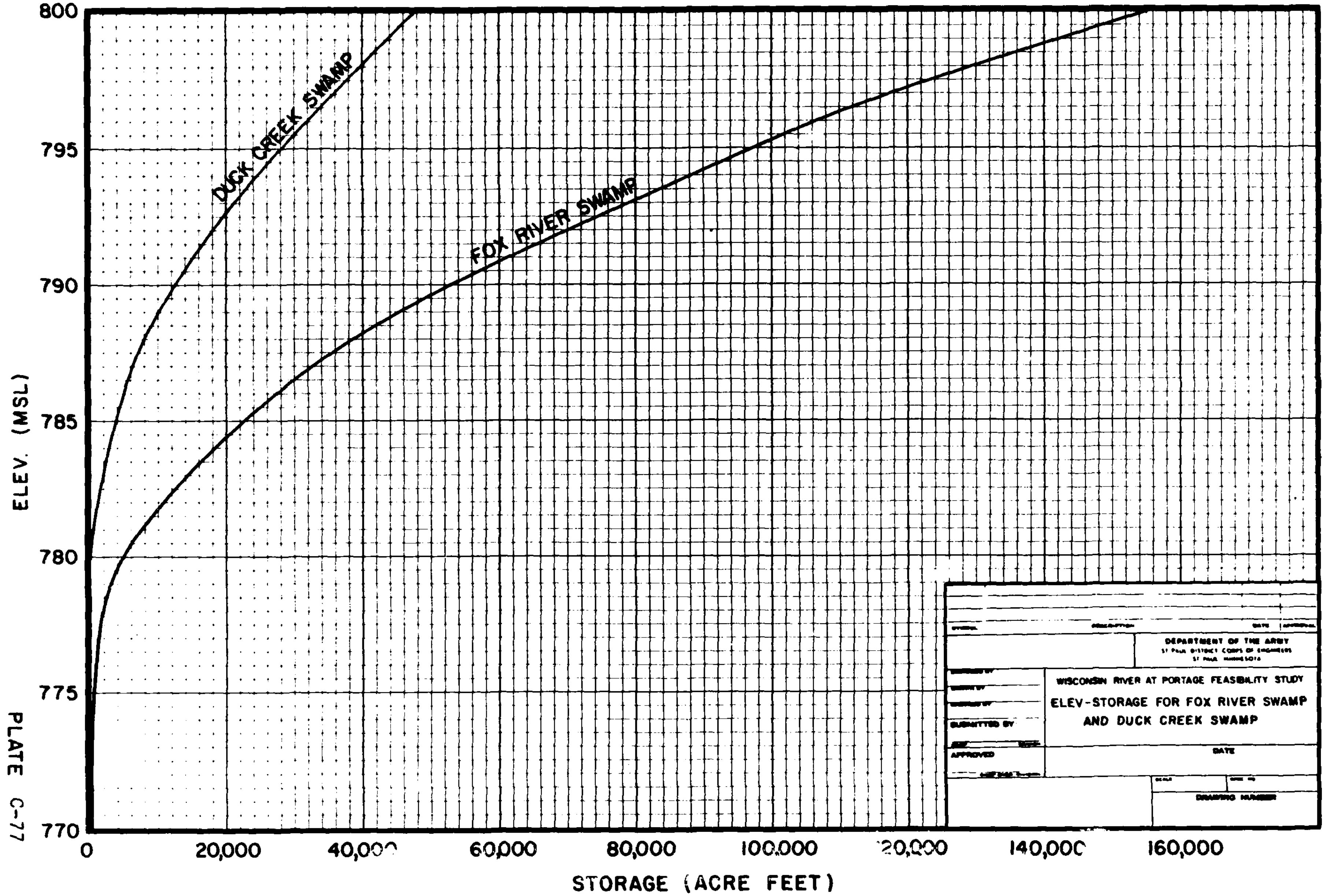

810
805
800
795
790
785
780
ELEVATION ABOVE M.S.L.
0
10
20
30
40
50
60
70
80
90
STORAGE (ACRE FEET X 1000)
FIRST LEWISTON RESERVOIR
SECOND LEWISTON RESERVOIR
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEVATION-STORAGE RELATIONSHIPS
FOR THE FIRST AND SECOND
LEWISTON RESERVOIRS
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

PLATE C-75

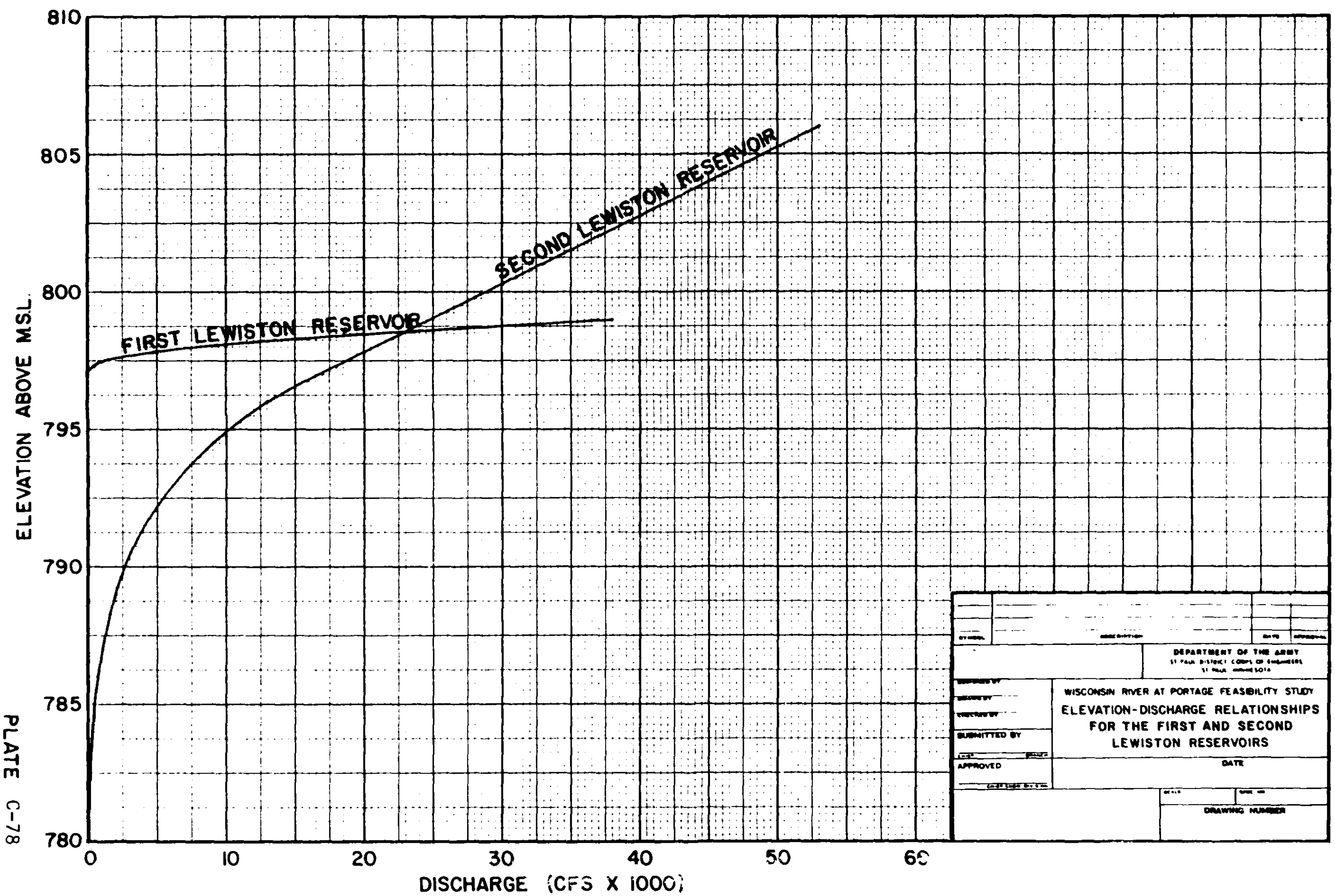


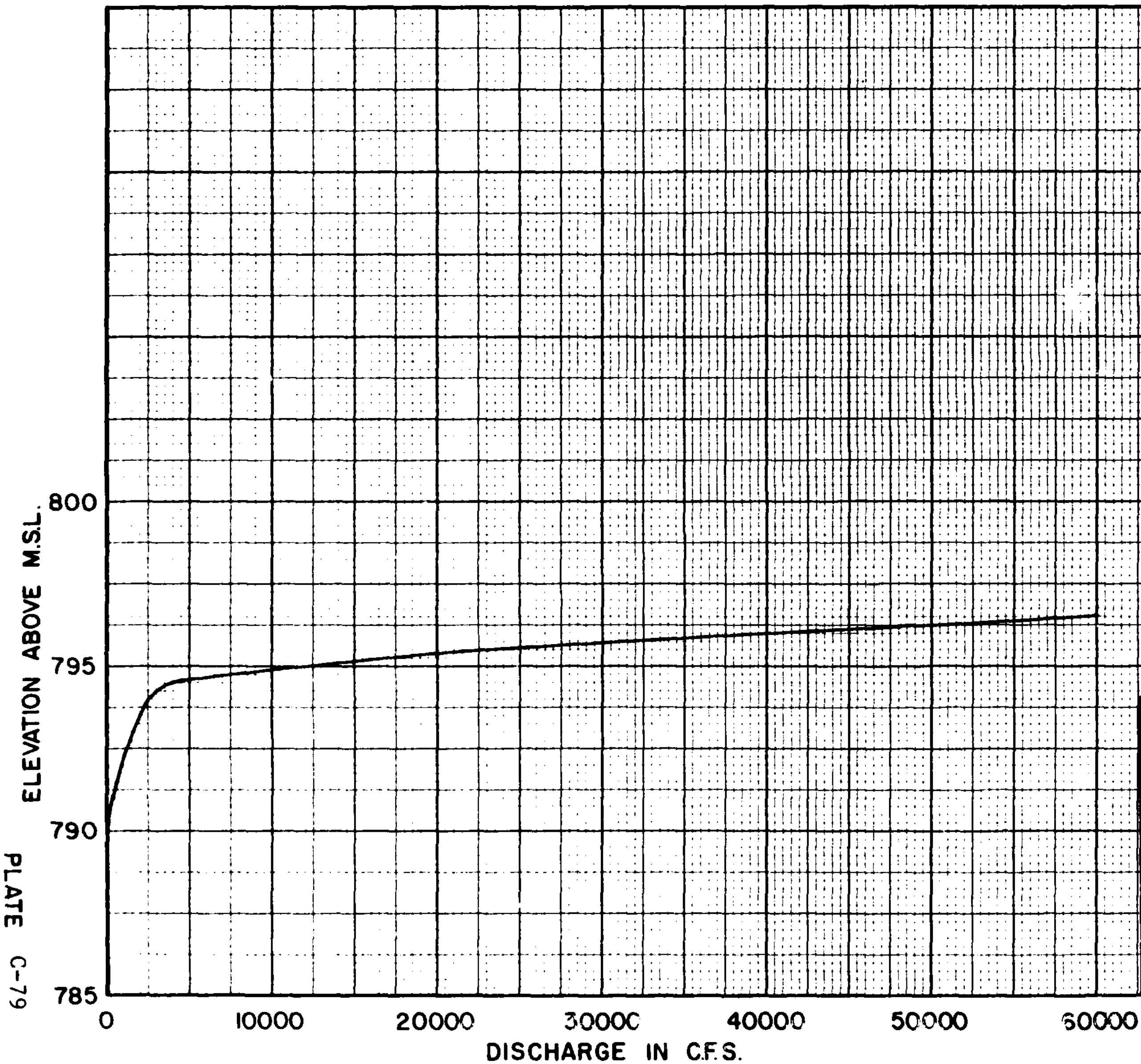
797
796
795
794
793
792
791
790
789
788
787
786
785
ELEVATION ABOVE MSL
0
1000
2000
3000
4000
5000
6000
7000
8000
STORAGE (ACRE FEET)
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEVATION-STORAGE RELATIONSHIP
FOR THE CALEDONIA RESERVOIR
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER



DUCK CREEK SWAMP
FOX RIVER SWAMP
800
795
790
785
780
775
770
ELEV. (MSL)
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
160,000
STORAGE (ACRE FEET)
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEV-STORAGE FOR FOX RIVER SWAMP
AND DUCK CREEK SWAMP
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

PLATE C-77


810
805
800
795
790
785
780
ELEVATION ABOVE MSL
0
10
20
30
40
50
60
DISCHARGE (CFS X 1000)
FIRST LEWISTON RESERVOIR
SECOND LEWISTON RESERVOIR
DEPARTMENT OF THE ARMY
SUBMITTED BY
APPROVED
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEVATION-DISCHARGE RELATIONSHIPS
FOR THE FIRST AND SECOND
LEWISTON RESERVOIRS
DATE
DRAWING NUMBER



DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

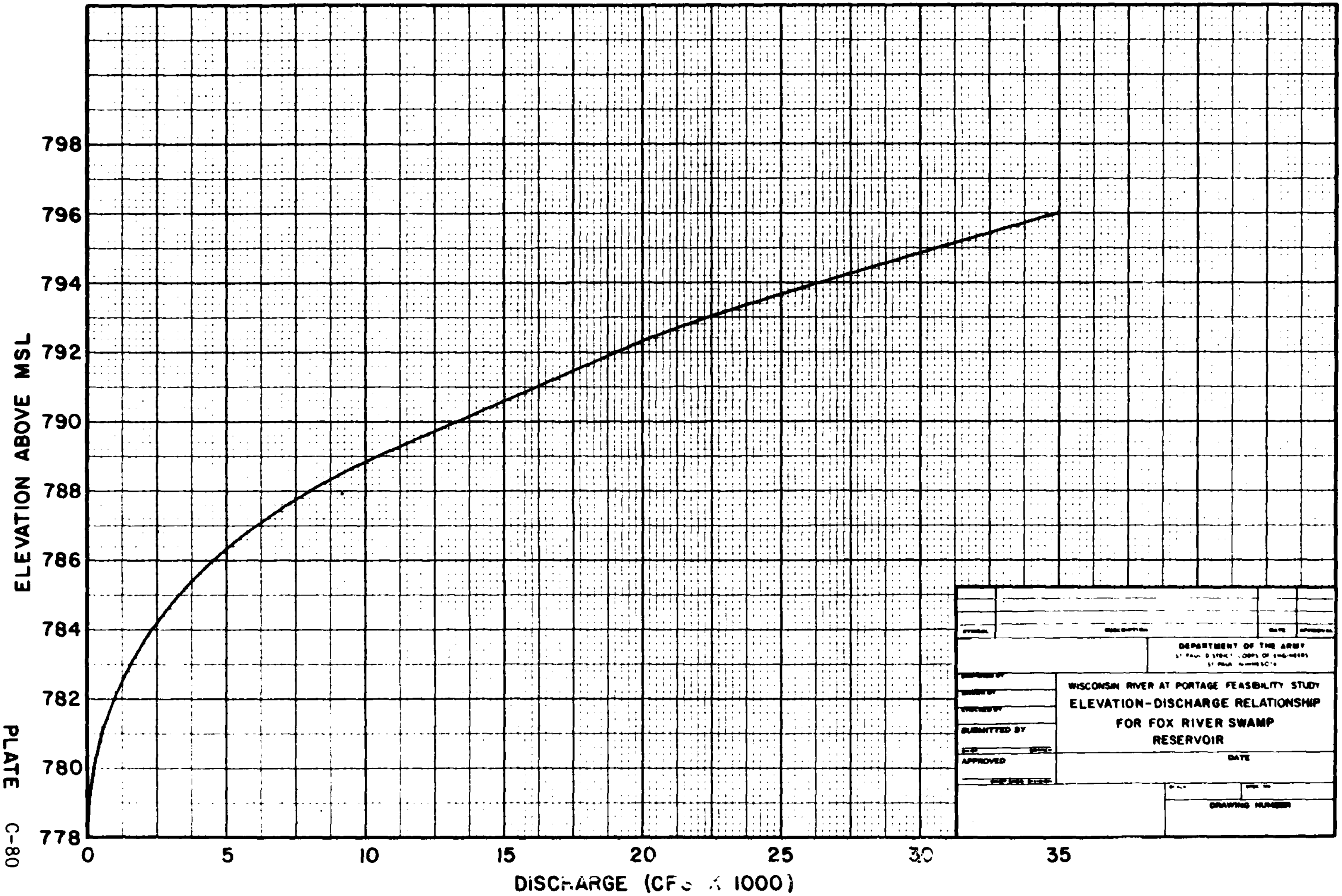
ELEVATION-DISCHARGE RELATIONSHIP
FOR CALEDONIA RESERVOIR

SUBMITTED BY

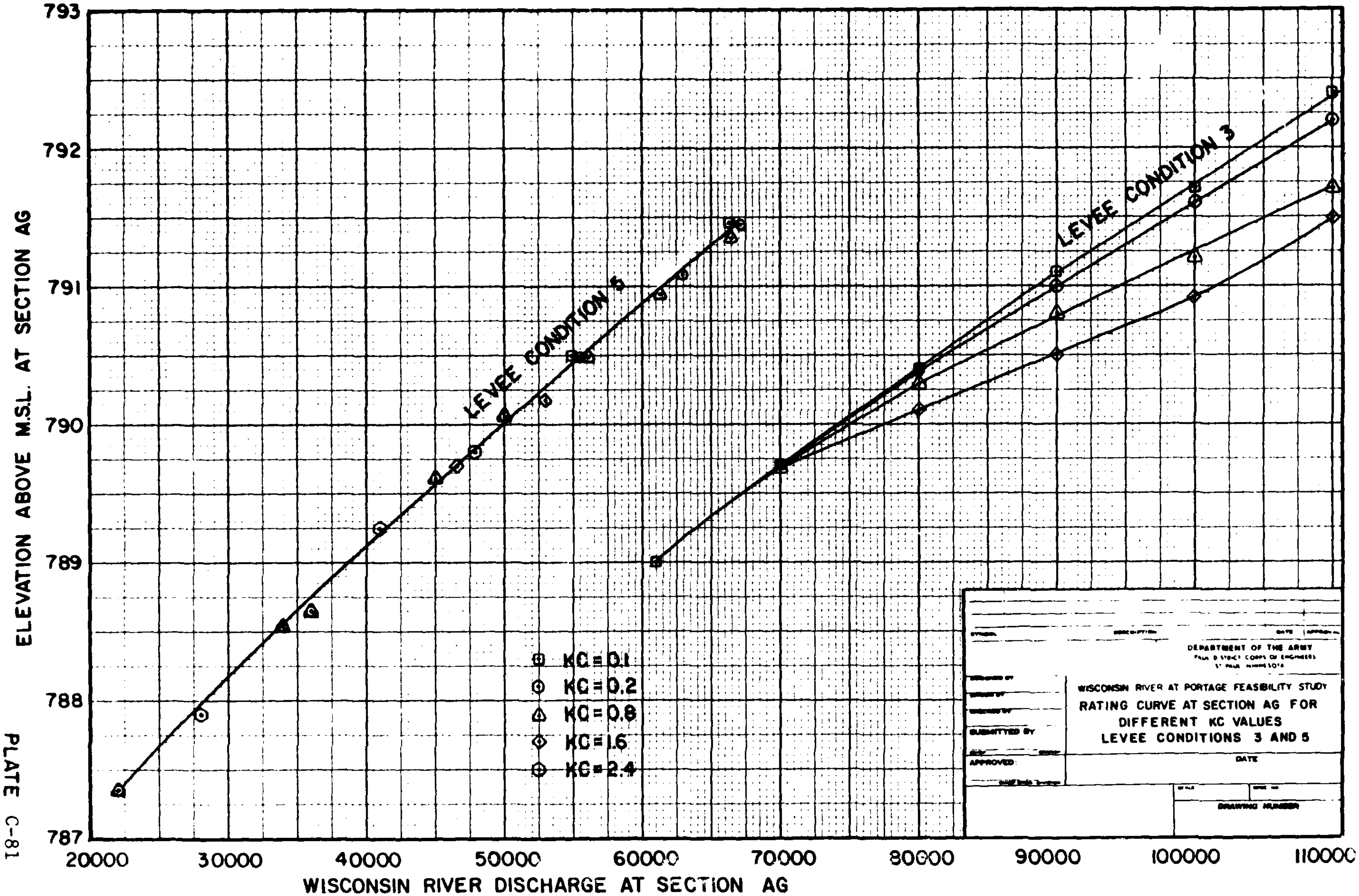
APPROVED

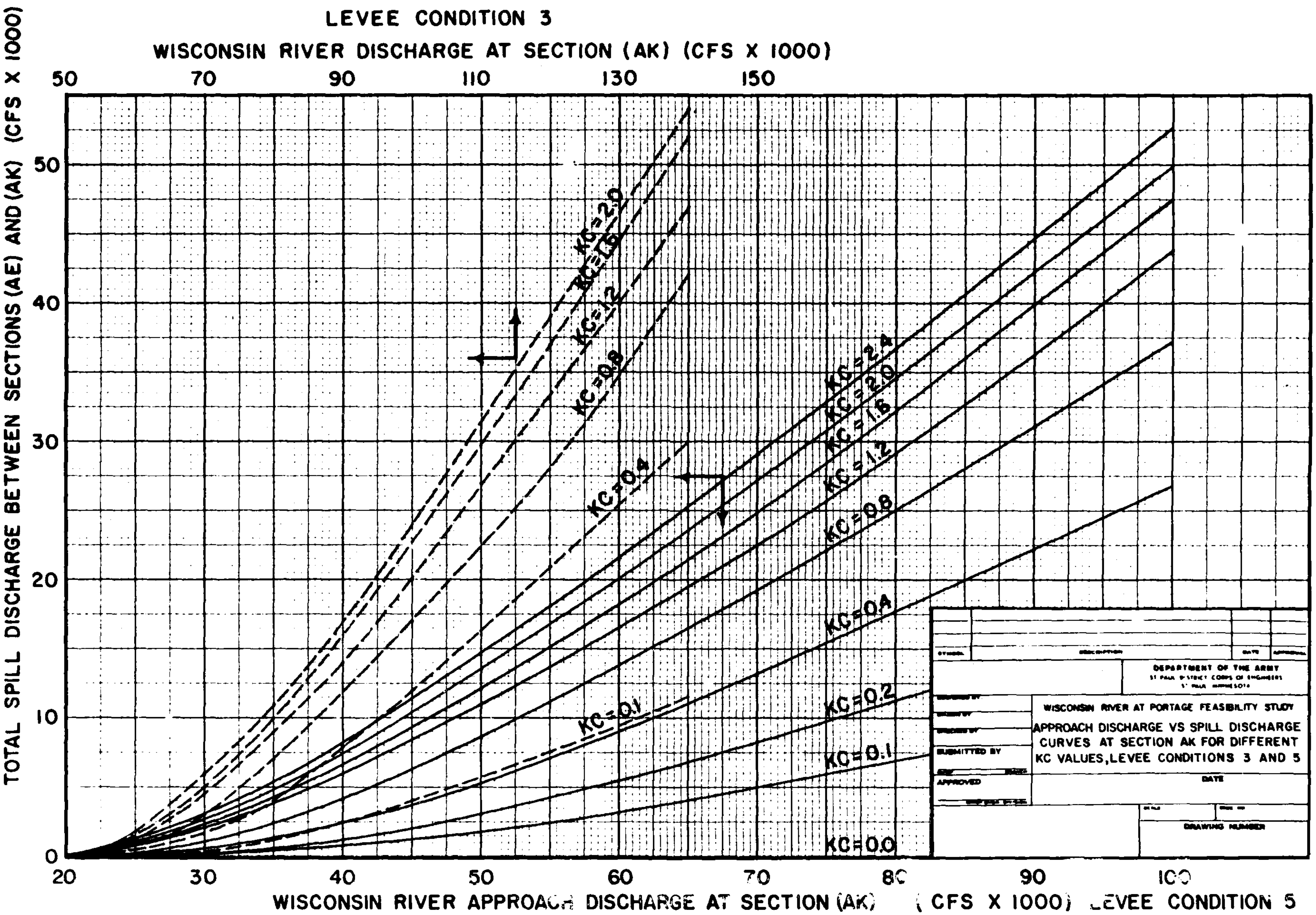
DATE

DRAWING NUMBER

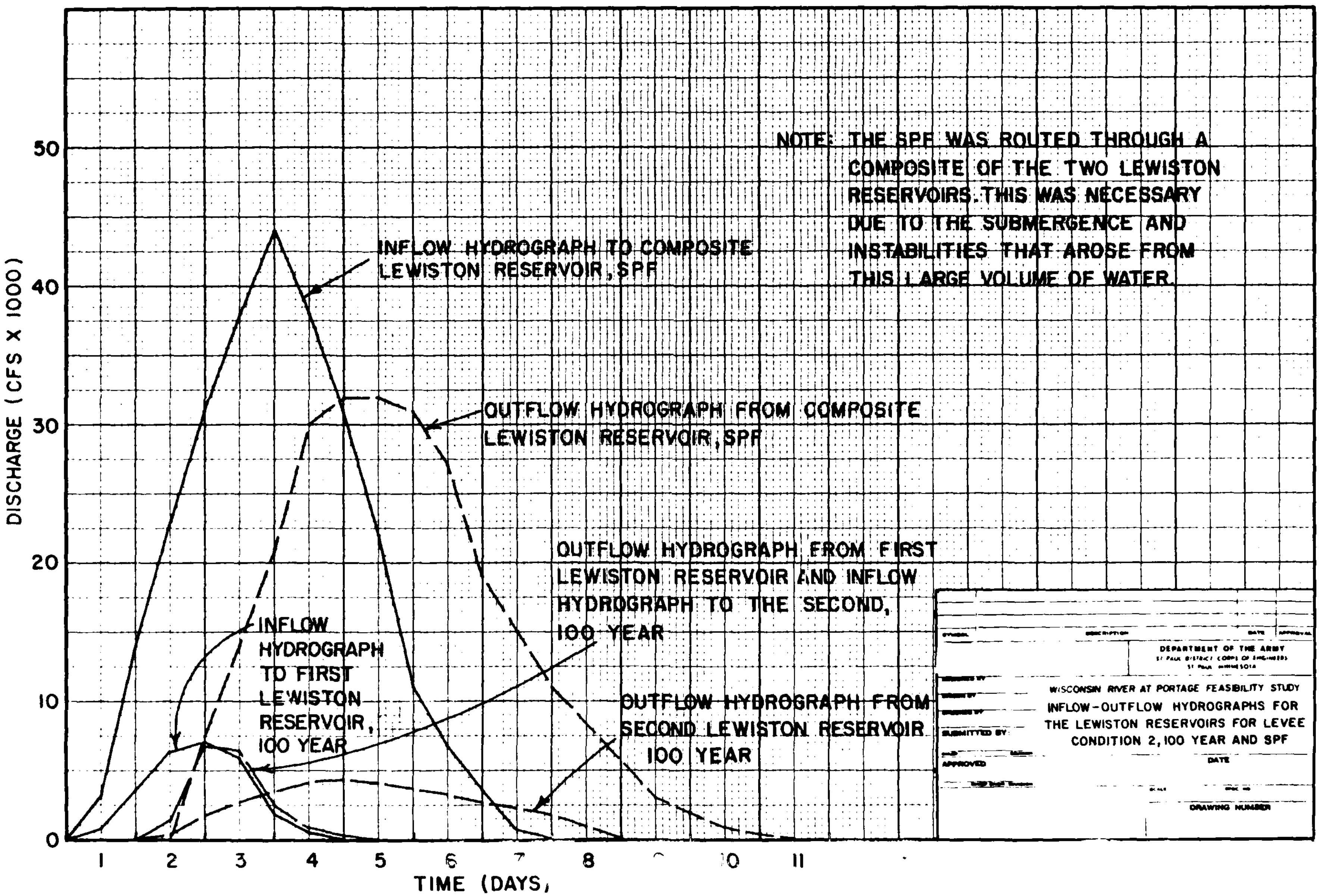


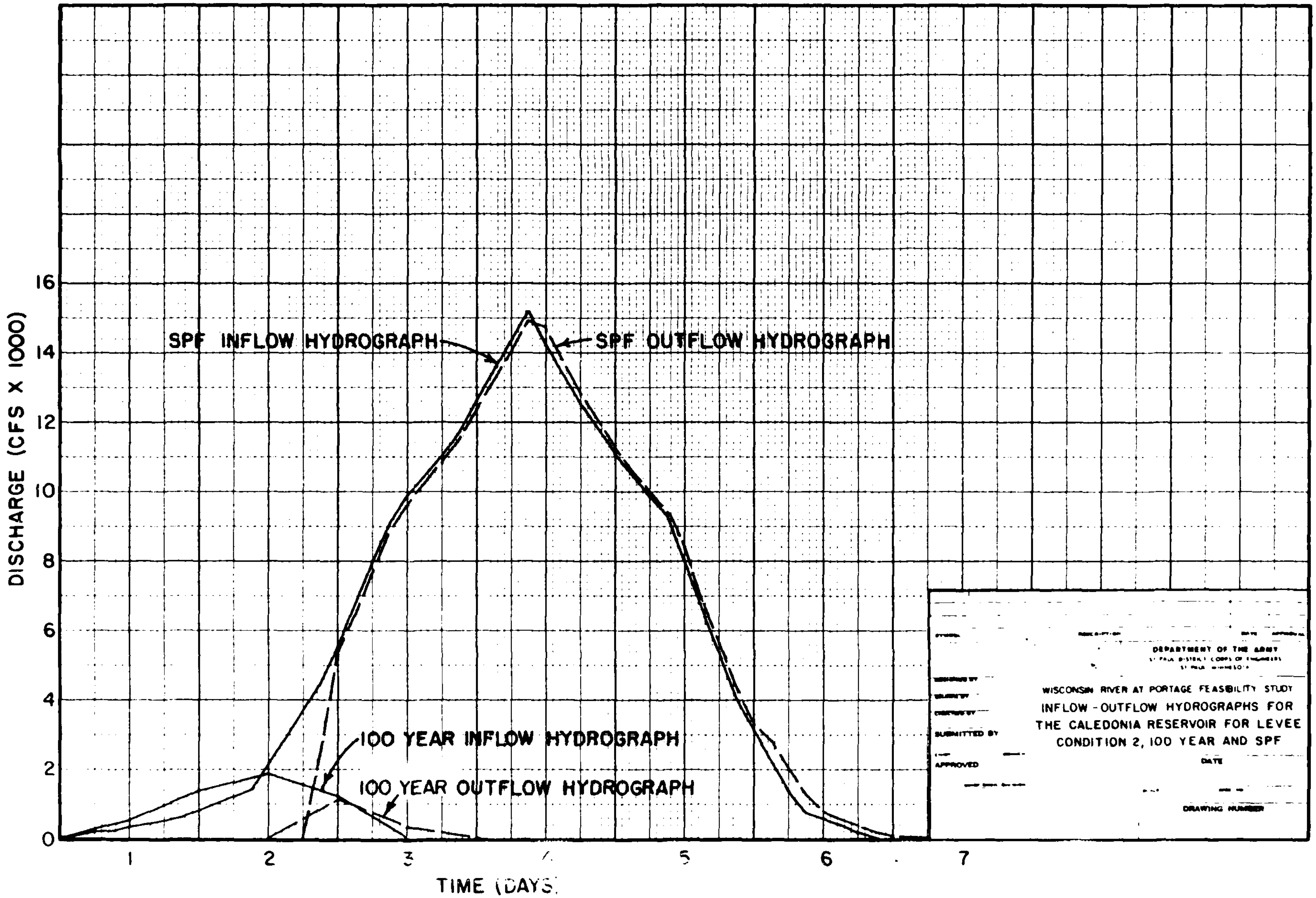
ELEVATION ABOVE MSL
798
796
794
792
790
788
786
784
782
780
778
0
5
10
15
20
25
30
35
DISCHARGE (CFS X 1000)
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEVATION-DISCHARGE RELATIONSHIP
FOR FOX RIVER SWAMP
RESERVOIR
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER


793
792
791
790
789
788
787
20000
30000
40000
50000
60000
70000
80000
90000
100000
110000
ELEVATION ABOVE M.S.L. AT SECTION AG
WISCONSIN RIVER DISCHARGE AT SECTION AG
LEVEE CONDITION 5
LEVEE CONDITION 3
KC = 0.1
KC = 0.2
KC = 0.8
KC = 1.6
KC = 2.4
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
RATING CURVE AT SECTION AG FOR
DIFFERENT KC VALUES
LEVEE CONDITIONS 3 AND 5
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER



LEVEE CONDITION 3
WISCONSIN RIVER DISCHARGE AT SECTION (AK) (CFS X 1000)
50
70
90
110
130
150
TOTAL SPILL DISCHARGE BETWEEN SECTIONS (AE) AND (AK) (CFS X 1000)
0
10
20
30
40
50
KC=2.0
KC=1.6
KC=1.2
KC=0.8
KC=0.4
KC=0.1
KC=2.4
KC=2.0
KC=1.6
KC=1.2
KC=0.8
KC=0.4
KC=0.2
KC=0.1
KC=0.0
20
30
40
50
60
70
80
90
100
WISCONSIN RIVER APPROACH DISCHARGE AT SECTION (AK) (CFS X 1000) LEVEE CONDITION 5
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
APPROACH DISCHARGE VS SPILL DISCHARGE CURVES AT SECTION AK FOR DIFFERENT KC VALUES, LEVEE CONDITIONS 3 AND 5
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER


NOTE: THE SPF WAS ROUTED THROUGH A COMPOSITE OF THE TWO LEWISTON RESERVOIRS. THIS WAS NECESSARY DUE TO THE SUBMERGENCE AND INSTABILITIES THAT AROSE FROM THIS LARGE VOLUME OF WATER.
INFLOW HYDROGRAPH TO COMPOSITE LEWISTON RESERVOIR, SPF
OUTFLOW HYDROGRAPH FROM COMPOSITE LEWISTON RESERVOIR, SPF
OUTFLOW HYDROGRAPH FROM FIRST LEWISTON RESERVOIR AND INFLOW HYDROGRAPH TO THE SECOND, 100 YEAR
INFLOW HYDROGRAPH TO FIRST LEWISTON RESERVOIR, 100 YEAR
OUTFLOW HYDROGRAPH FROM SECOND LEWISTON RESERVOIR 100 YEAR
DISCHARGE (CFS X 1000)
0
10
20
30
40
50
TIME (DAYS)
1
2
3
4
5
6
7
8
10
11
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
INFLOW-OUTFLOW HYDROGRAPHS FOR THE LEWISTON RESERVOIRS FOR LEVEE CONDITION 2, 100 YEAR AND SPF
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER


SPF INFLOW HYDROGRAPH
SPF OUTFLOW HYDROGRAPH
100 YEAR INFLOW HYDROGRAPH
100 YEAR OUTFLOW HYDROGRAPH
DISCHARGE (CFS X 1000)
0
2
4
6
8
10
12
14
16
TIME (DAYS)
1
2
3
4
5
6
7
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
INFLOW - OUTFLOW HYDROGRAPHS FOR
THE CALEDONIA RESERVOIR FOR LEVEE
CONDITION 2, 100 YEAR AND SPF
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

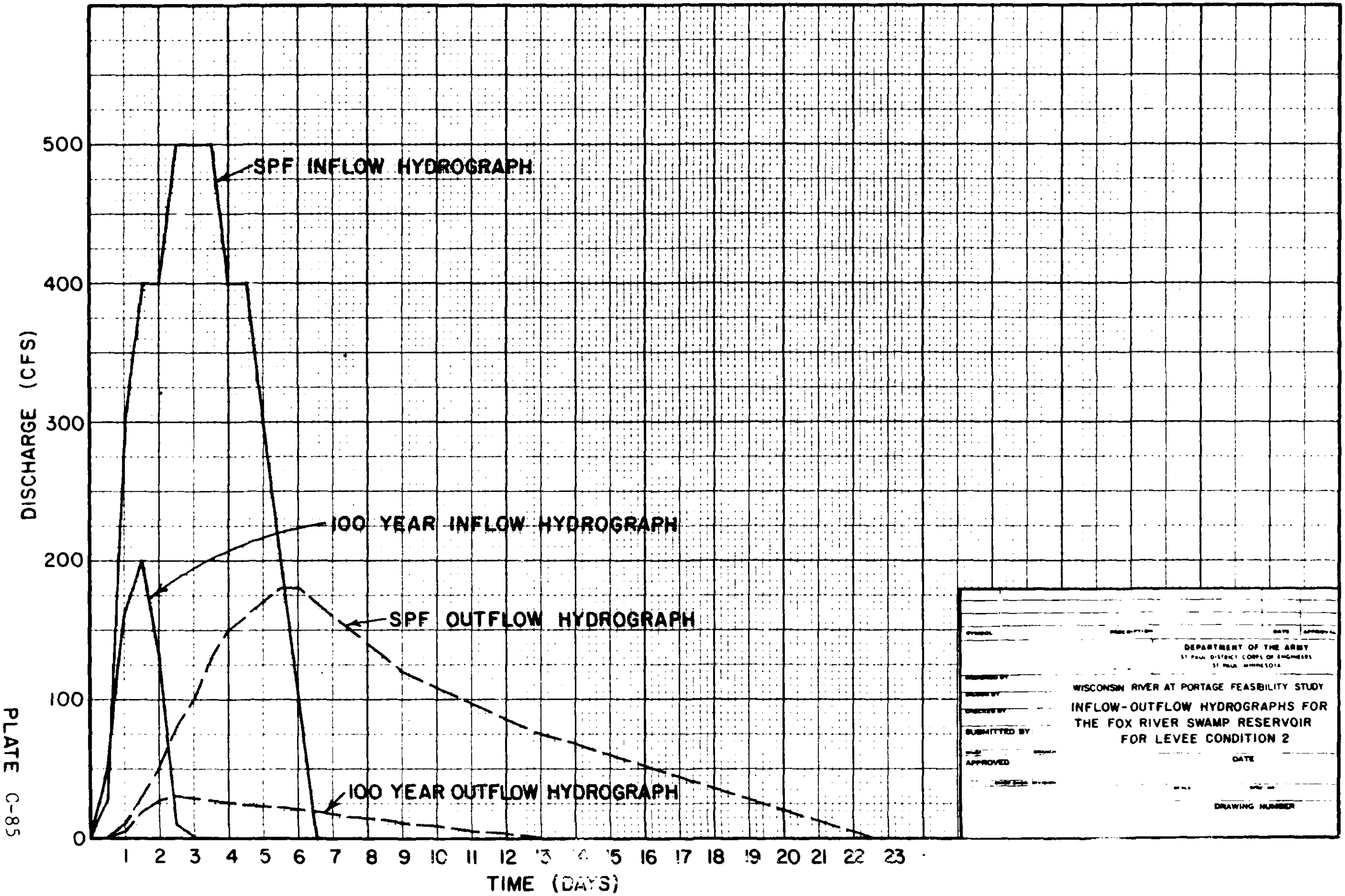
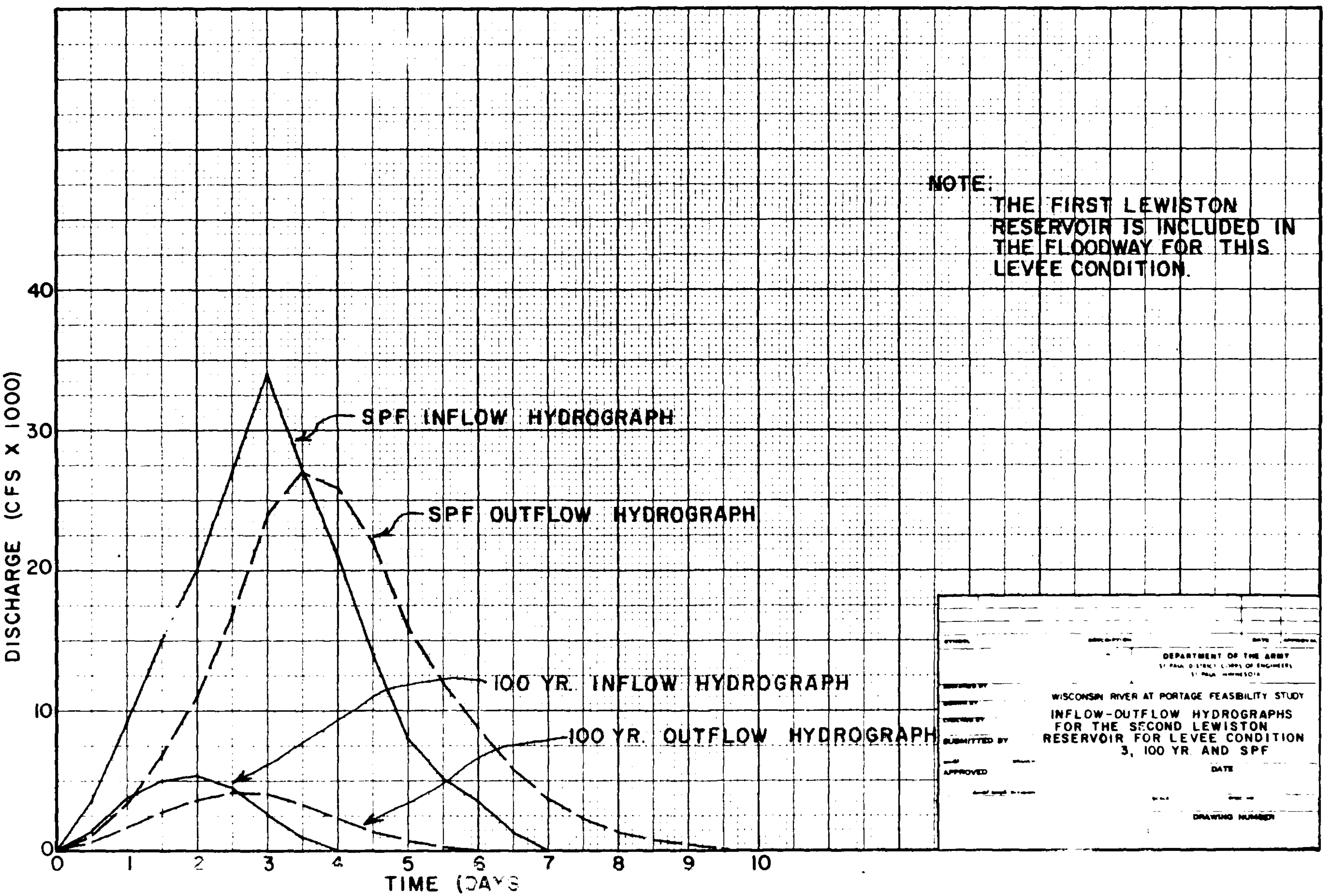
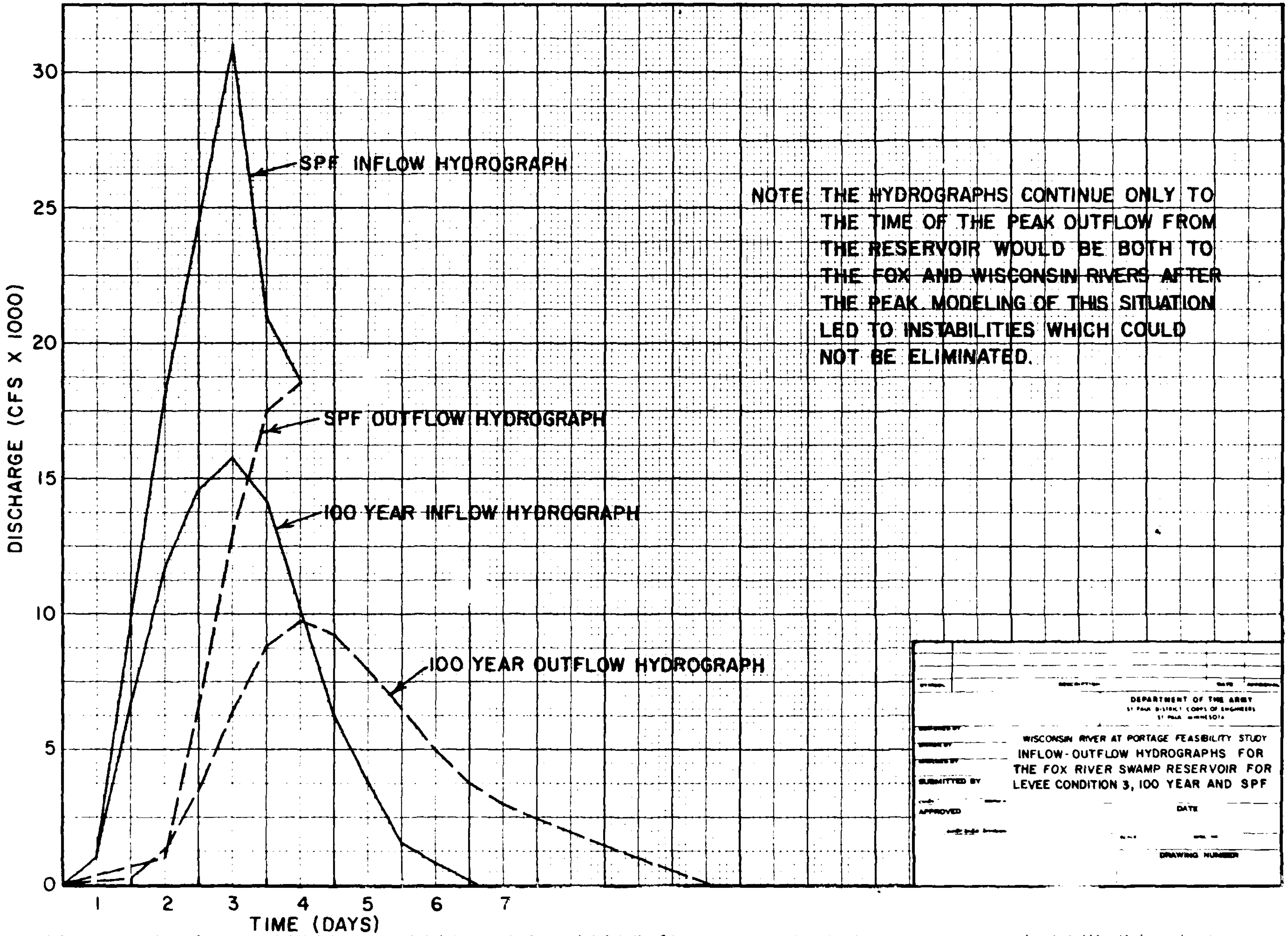

SPF INFLOW HYDROGRAPH
100 YEAR INFLOW HYDROGRAPH
SPF OUTFLOW HYDROGRAPH
100 YEAR OUTFLOW HYDROGRAPH
DISCHARGE (CFS)
TIME (DAYS)
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
INFLOW-OUTFLOW HYDROGRAPHS FOR
THE FOX RIVER SWAMP RESERVOIR
FOR LEVEE CONDITION 2
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

PLATE C-85


NOTE:
THE FIRST LEWISTON RESERVOIR IS INCLUDED IN THE FLOODWAY FOR THIS LEVEE CONDITION.
SPF INFLOW HYDROGRAPH
SPF OUTFLOW HYDROGRAPH
100 YR. INFLOW HYDROGRAPH
100 YR. OUTFLOW HYDROGRAPH
DISCHARGE (CFS X 1000)
TIME (DAYS
0
10
20
30
40
1
2
3
4
5
6
7
8
9
10
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
INFLOW-OUTFLOW HYDROGRAPHS
FOR THE SECOND LEWISTON
RESERVOIR FOR LEVEE CONDITION
3, 100 YR AND SPF
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER



DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

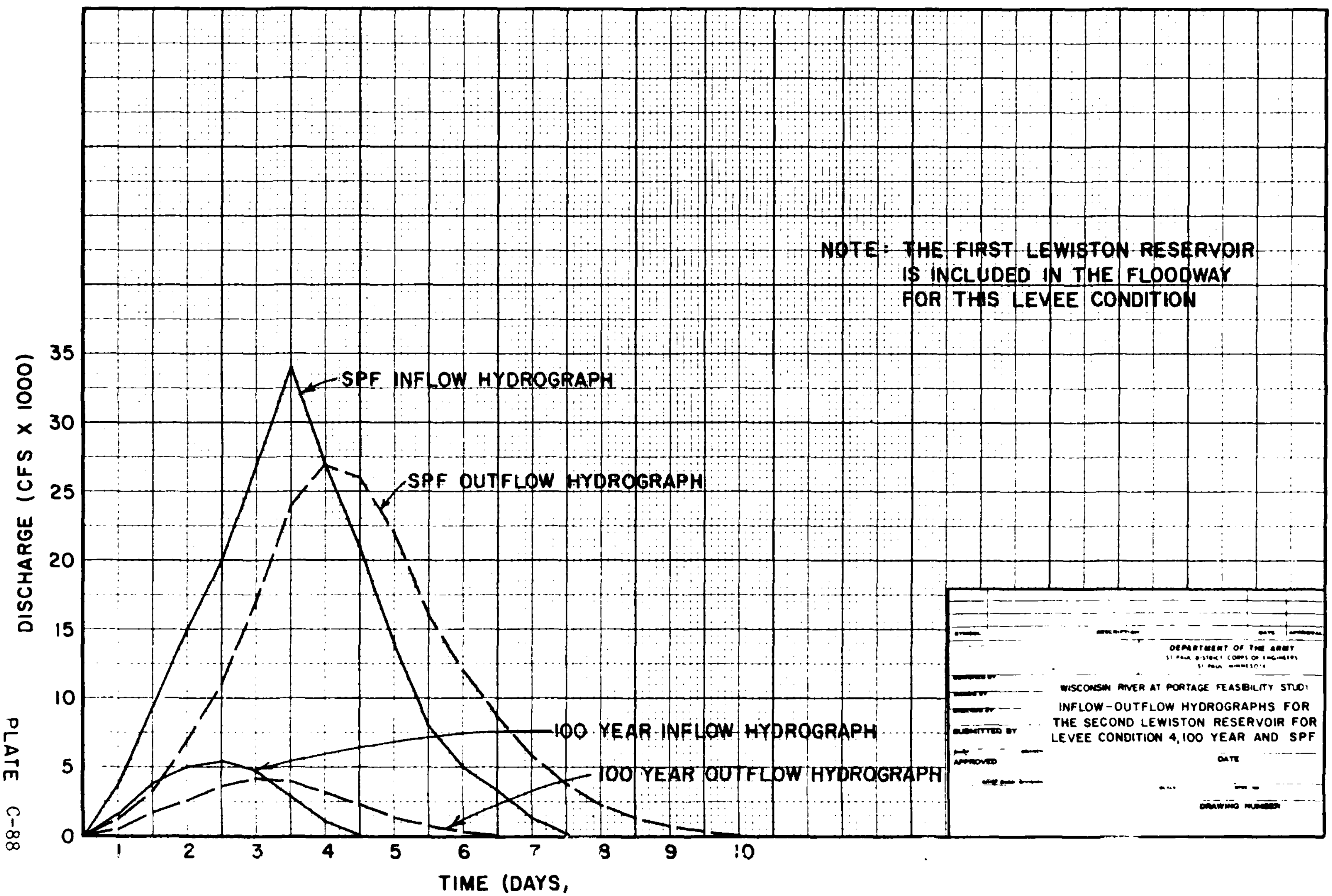
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
INFLOW-OUTFLOW HYDROGRAPHS FOR THE FOX RIVER SWAMP RESERVOIR FOR LEVEE CONDITION 3, 100 YEAR AND SPF

SUBMITTED BY

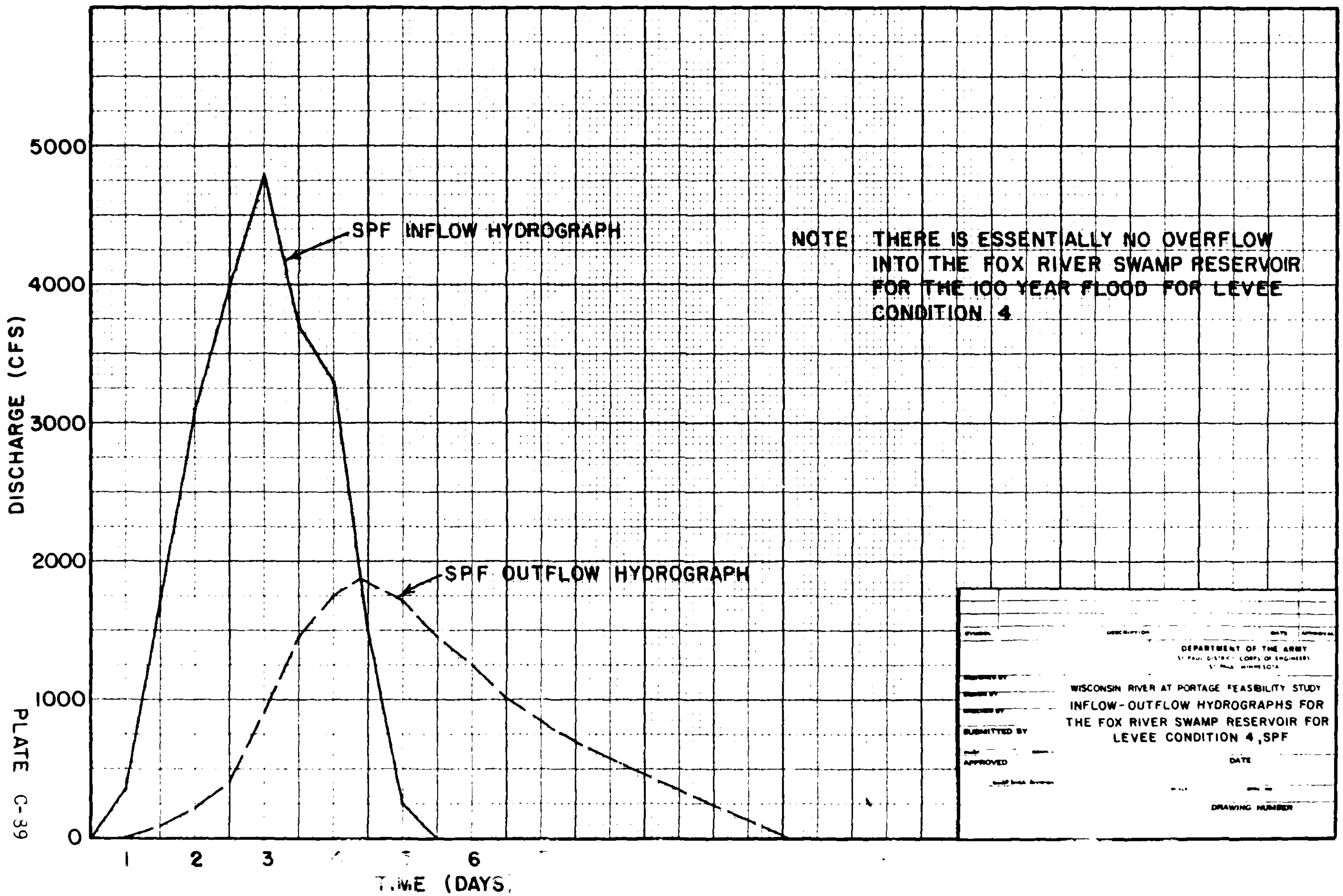
APPROVED

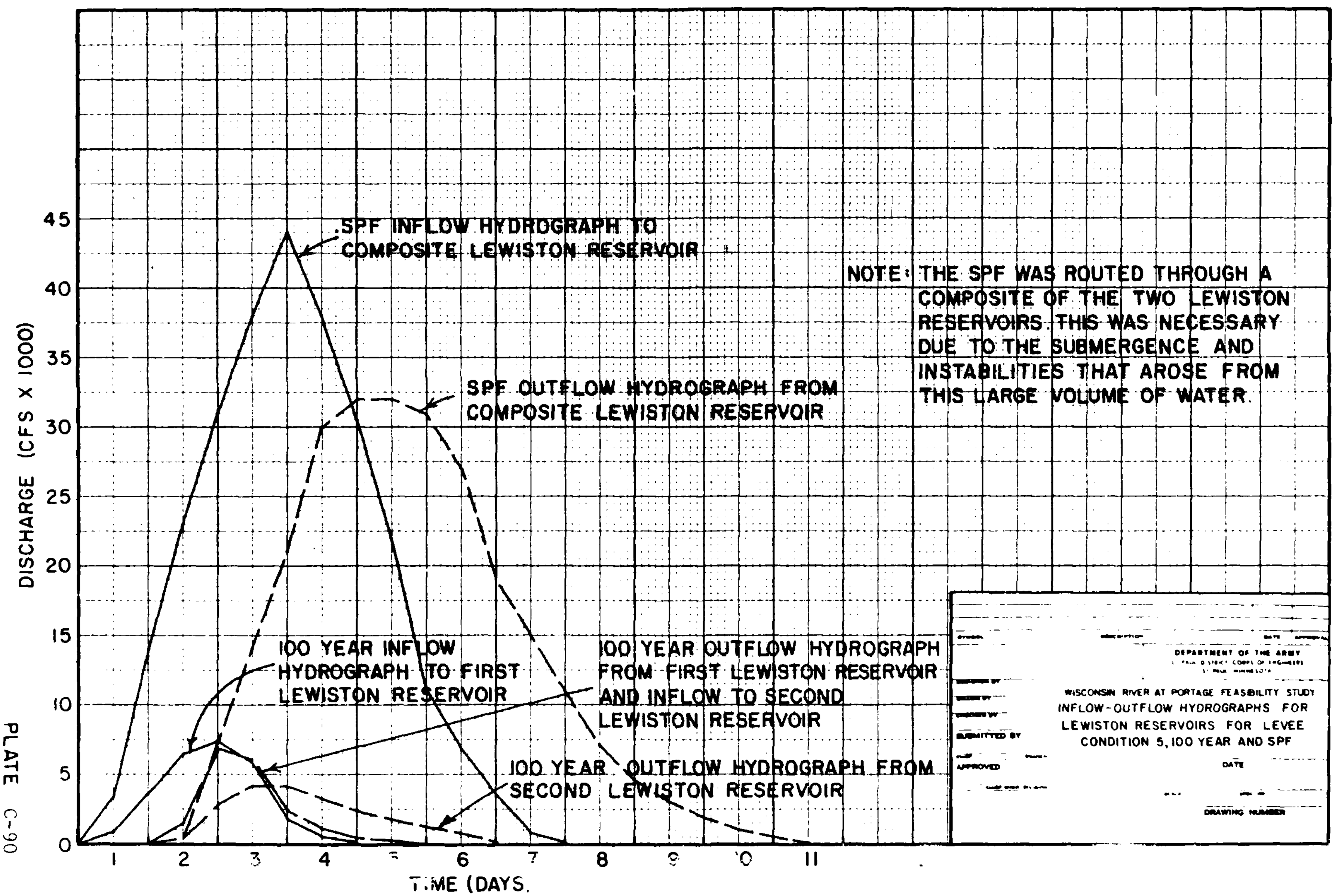
DATE

DRAWING NUMBER



NOTE: THE FIRST LEWISTON RESERVOIR IS INCLUDED IN THE FLOODWAY FOR THIS LEVEE CONDITION
SPF INFLOW HYDROGRAPH
SPF OUTFLOW HYDROGRAPH
100 YEAR INFLOW HYDROGRAPH
100 YEAR OUTFLOW HYDROGRAPH
DISCHARGE (CFS X 1000)
0
5
10
15
20
25
30
35
TIME (DAYS,
1
2
3
4
5
6
7
8
9
10
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
INFLOW-OUTFLOW HYDROGRAPHS FOR THE SECOND LEWISTON RESERVOIR FOR LEVEE CONDITION 4,100 YEAR AND SPF
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER


5000
4000
3000
2000
1000
0
DISCHARGE (CFS)
1
2
3
6
TIME (DAYS)
SPF INFLOW HYDROGRAPH
SPF OUTFLOW HYDROGRAPH
NOTE: THERE IS ESSENTIALLY NO OVERFLOW INTO THE FOX RIVER SWAMP RESERVOIR FOR THE 100 YEAR FLOOD FOR LEVEE CONDITION 4
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
INFLOW-OUTFLOW HYDROGRAPHS FOR THE FOX RIVER SWAMP RESERVOIR FOR LEVEE CONDITION 4, SPF
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER


SPF INFLOW HYDROGRAPH TO COMPOSITE LEWISTON RESERVOIR
SPF OUTFLOW HYDROGRAPH FROM COMPOSITE LEWISTON RESERVOIR
NOTE: THE SPF WAS ROUTED THROUGH A COMPOSITE OF THE TWO LEWISTON RESERVOIRS. THIS WAS NECESSARY DUE TO THE SUBMERGENCE AND INSTABILITIES THAT AROSE FROM THIS LARGE VOLUME OF WATER.
100 YEAR INFLOW HYDROGRAPH TO FIRST LEWISTON RESERVOIR
100 YEAR OUTFLOW HYDROGRAPH FROM FIRST LEWISTON RESERVOIR AND INFLOW TO SECOND LEWISTON RESERVOIR
100 YEAR OUTFLOW HYDROGRAPH FROM SECOND LEWISTON RESERVOIR
DISCHARGE (CFS X 1000)
0
5
10
15
20
25
30
35
40
45
TIME (DAYS)
1
2
3
4
6
7
8
10
11
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
INFLOW-OUTFLOW HYDROGRAPHS FOR LEWISTON RESERVOIRS FOR LEVEE CONDITION 5, 100 YEAR AND SPF
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

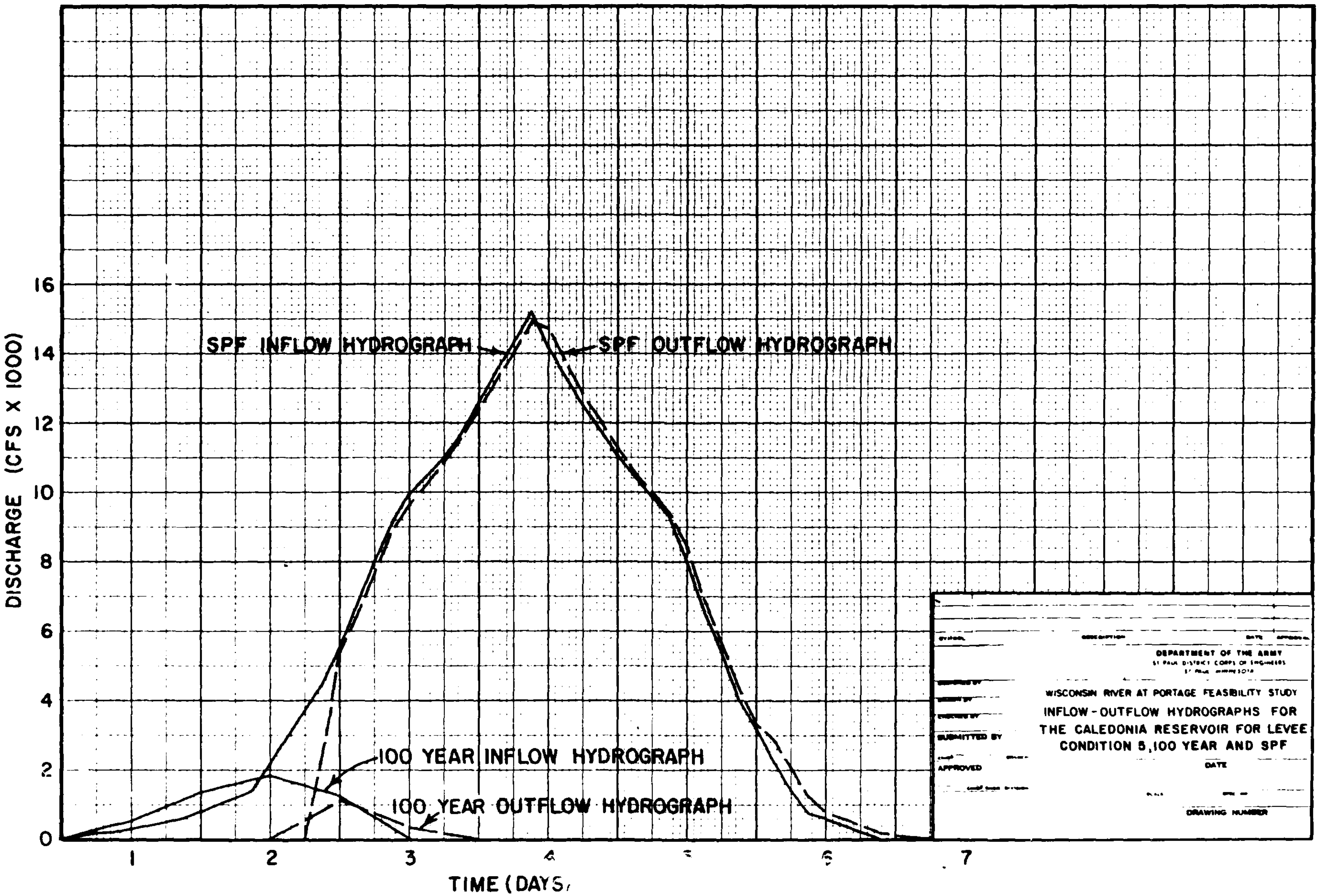

SPF INFLOW HYDROGRAPH
SPF OUTFLOW HYDROGRAPH
100 YEAR INFLOW HYDROGRAPH
100 YEAR OUTFLOW HYDROGRAPH
DISCHARGE (CFS X 1000)
0
2
4
6
8
10
12
14
16
TIME (DAYS)
1
2
3
4
5
6
7
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
INFLOW - OUTFLOW HYDROGRAPHS FOR THE CALEDONIA RESERVOIR FOR LEVEE CONDITION 5,100 YEAR AND SPF
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

PLATE C-91

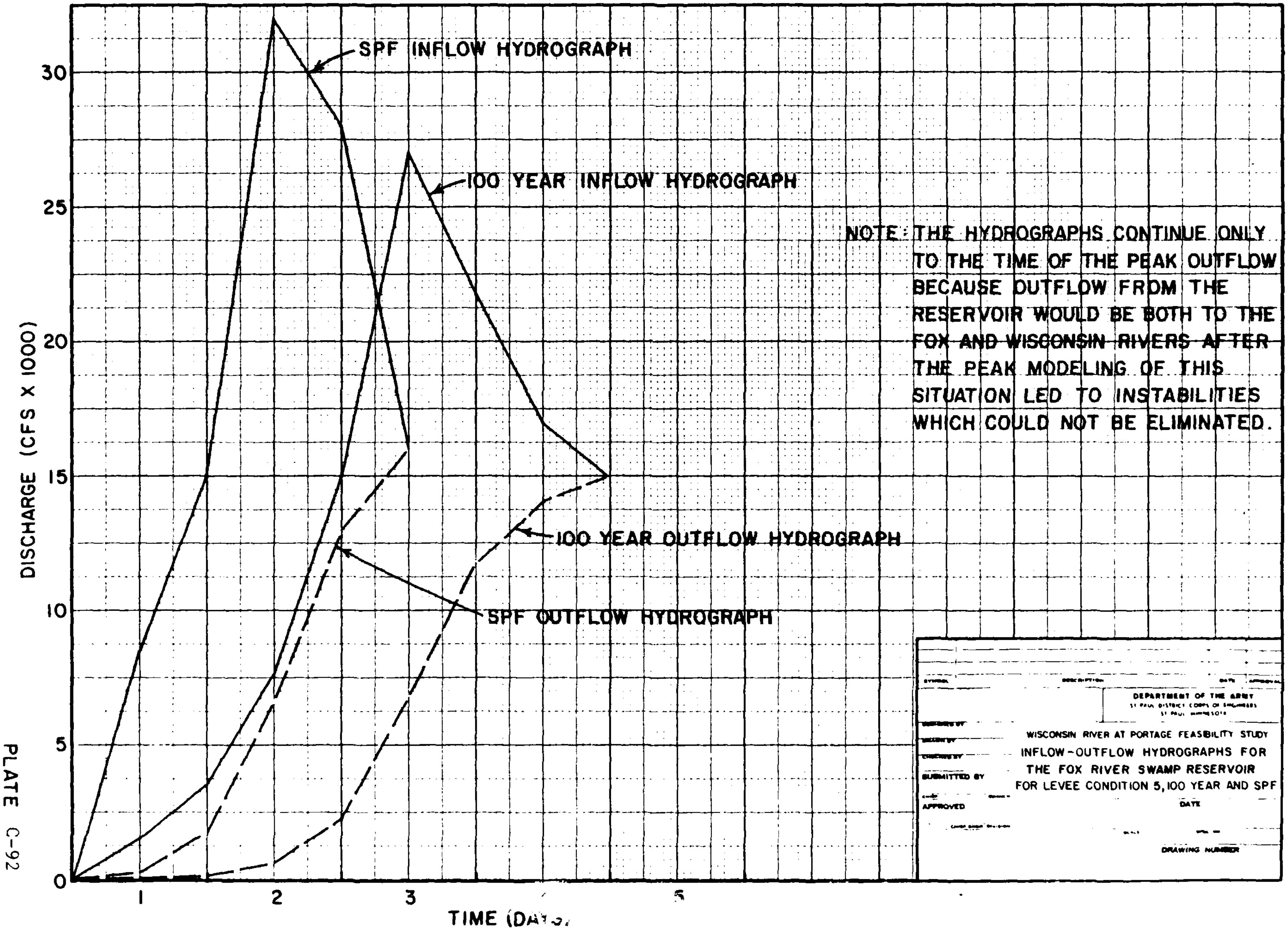
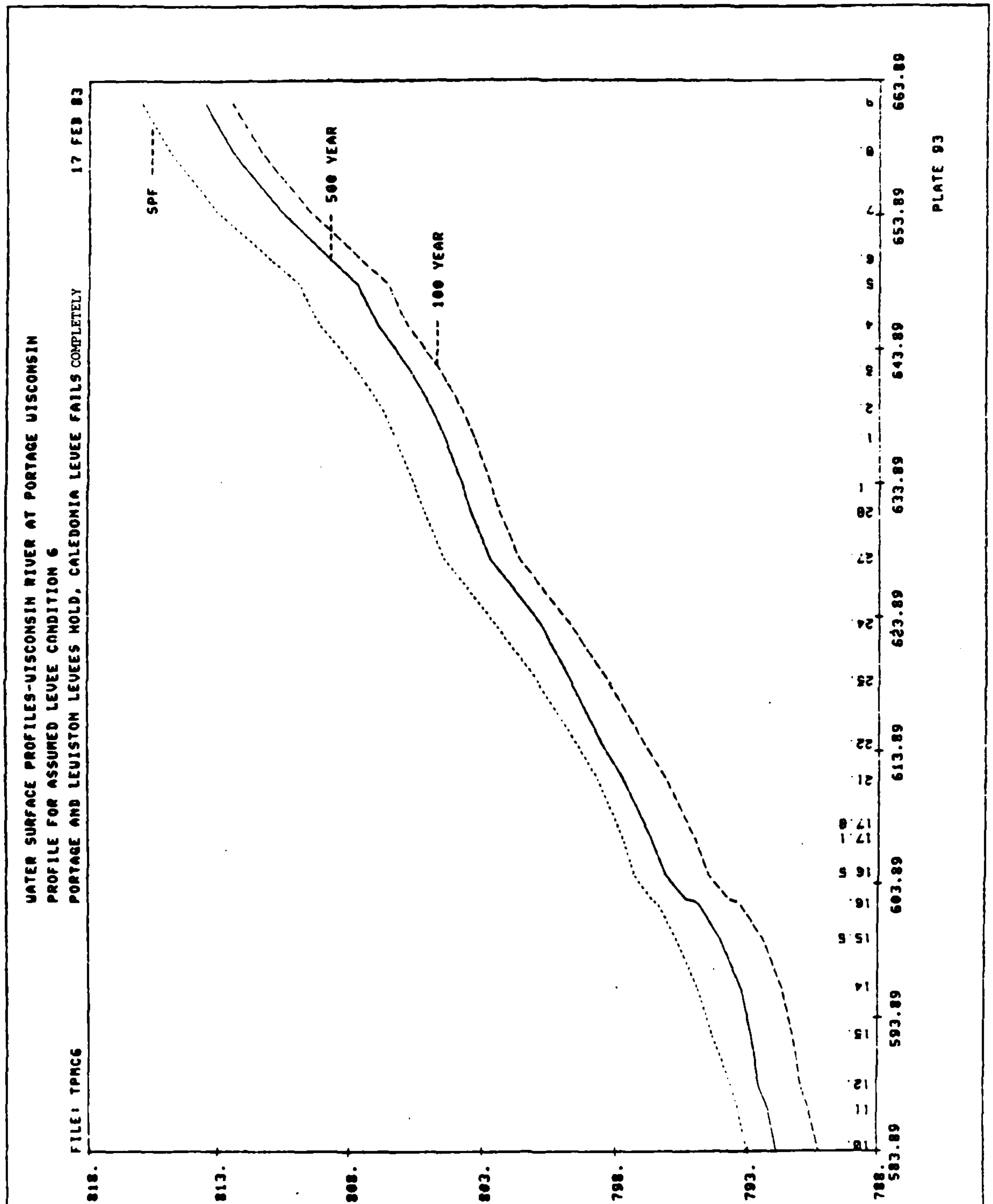

SPF INFLOW HYDROGRAPH
100 YEAR INFLOW HYDROGRAPH
100 YEAR OUTFLOW HYDROGRAPH
SPF OUTFLOW HYDROGRAPH
NOTE: THE HYDROGRAPHS CONTINUE ONLY TO THE TIME OF THE PEAK OUTFLOW BECAUSE OUTFLOW FROM THE RESERVOIR WOULD BE BOTH TO THE FOX AND WISCONSIN RIVERS AFTER THE PEAK MODELING OF THIS SITUATION LED TO INSTABILITIES WHICH COULD NOT BE ELIMINATED.
DISCHARGE (CFS X 1000)
0
5
10
15
20
25
30
1
2
3
5
TIME (DAYS)
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASBILITY STUDY
INFLOW-OUTFLOW HYDROGRAPHS FOR
THE FOX RIVER SWAMP RESERVOIR
FOR LEVEE CONDITION 5, 100 YEAR AND SPF
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

PLATE C-92



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
CHIEF, BRANCH
APPROVED
CHIEF, ENGR. DIVISION

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

WATER SURFACE PROFILE

ASSUMED LEVEE CONDITION 6

DATE

SCALE | SHEET NO.

DRAWING NUMBER

PLATE G-93

WATER SURFACE PROFILES-WISCONSIN RIVER AT PORTAGE WISCONSIN
PROFILE FOR ASSUMED LEVEE CONDITION 7

FILE: TPRC7

PORTAGE AND CALEDONIA LEVEES OVERTOPPED, LEWISTON LEVEE FAILS COMPLETELY

17 FEB 83

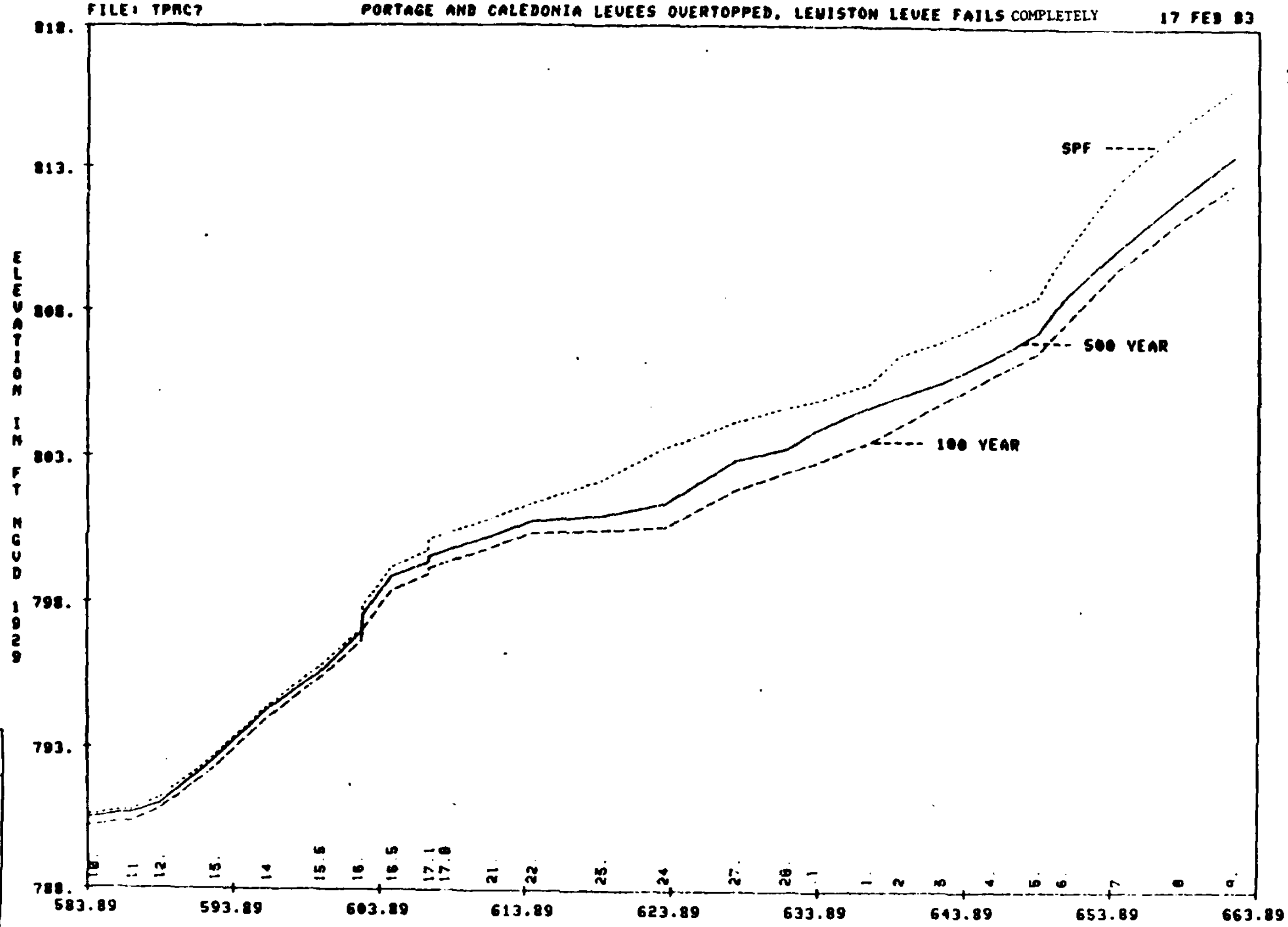


PLATE 94

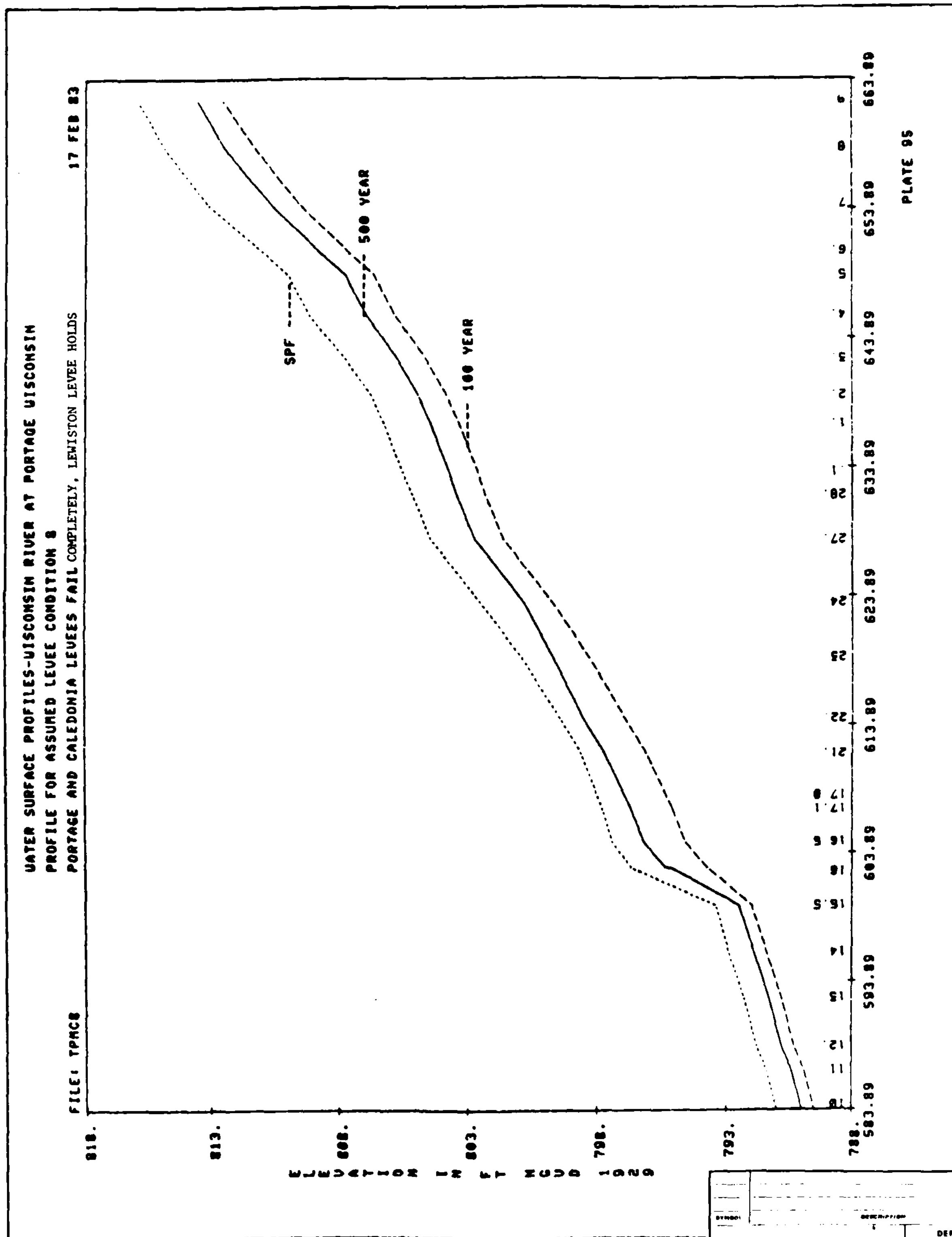
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

WATER SURFACE PROFILE
ASSUMED LEVEE CONDITION 7

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:
DATE

DRAWING NUMBER
PLATE C-94



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY
APPROVED:

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

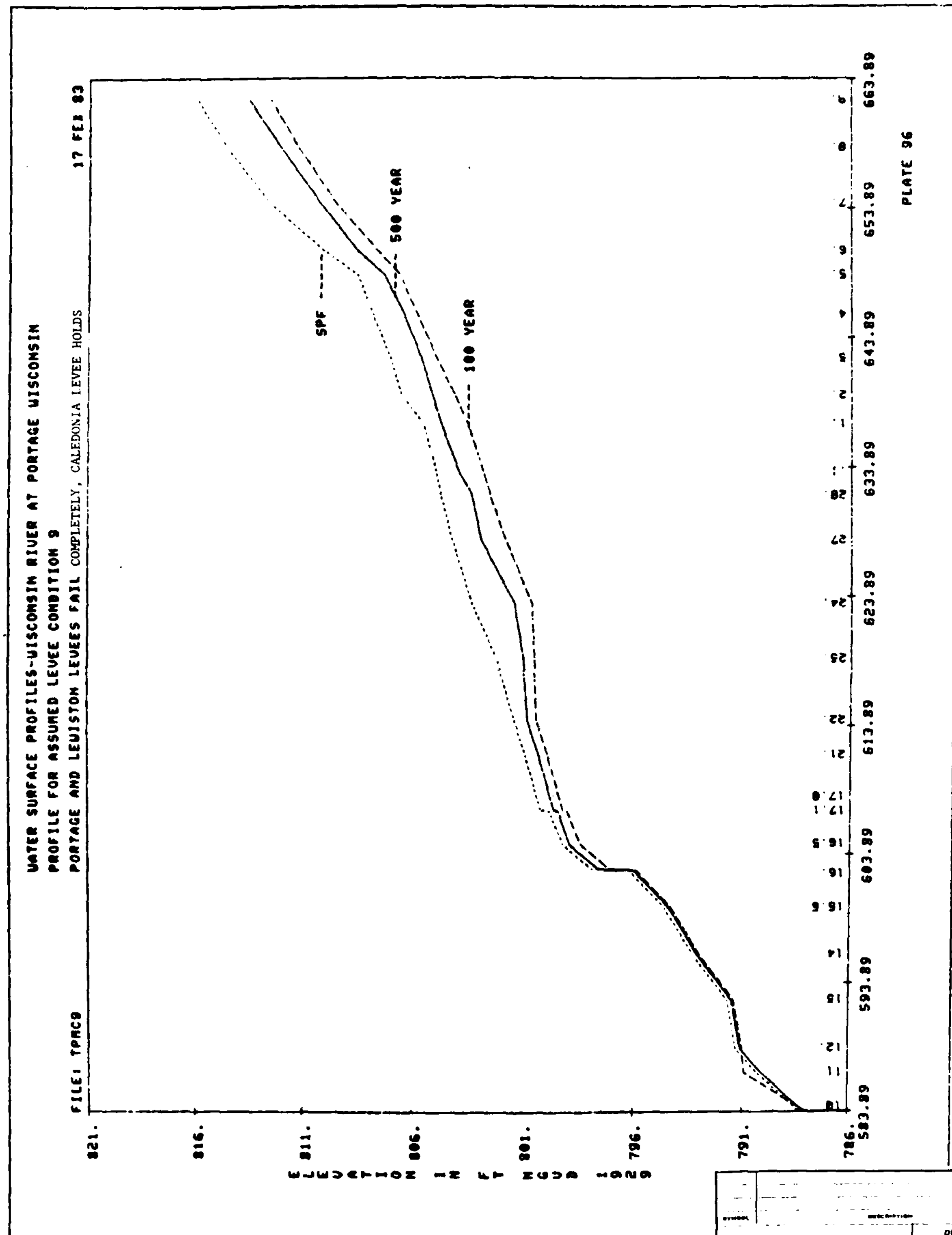
WATER SURFACE PROFILE

ASSUMED LEVEE CONDITION 8

DATE

DRAWING NUMBER

PLATE 95



DEPARTMENT OF THE ARMY

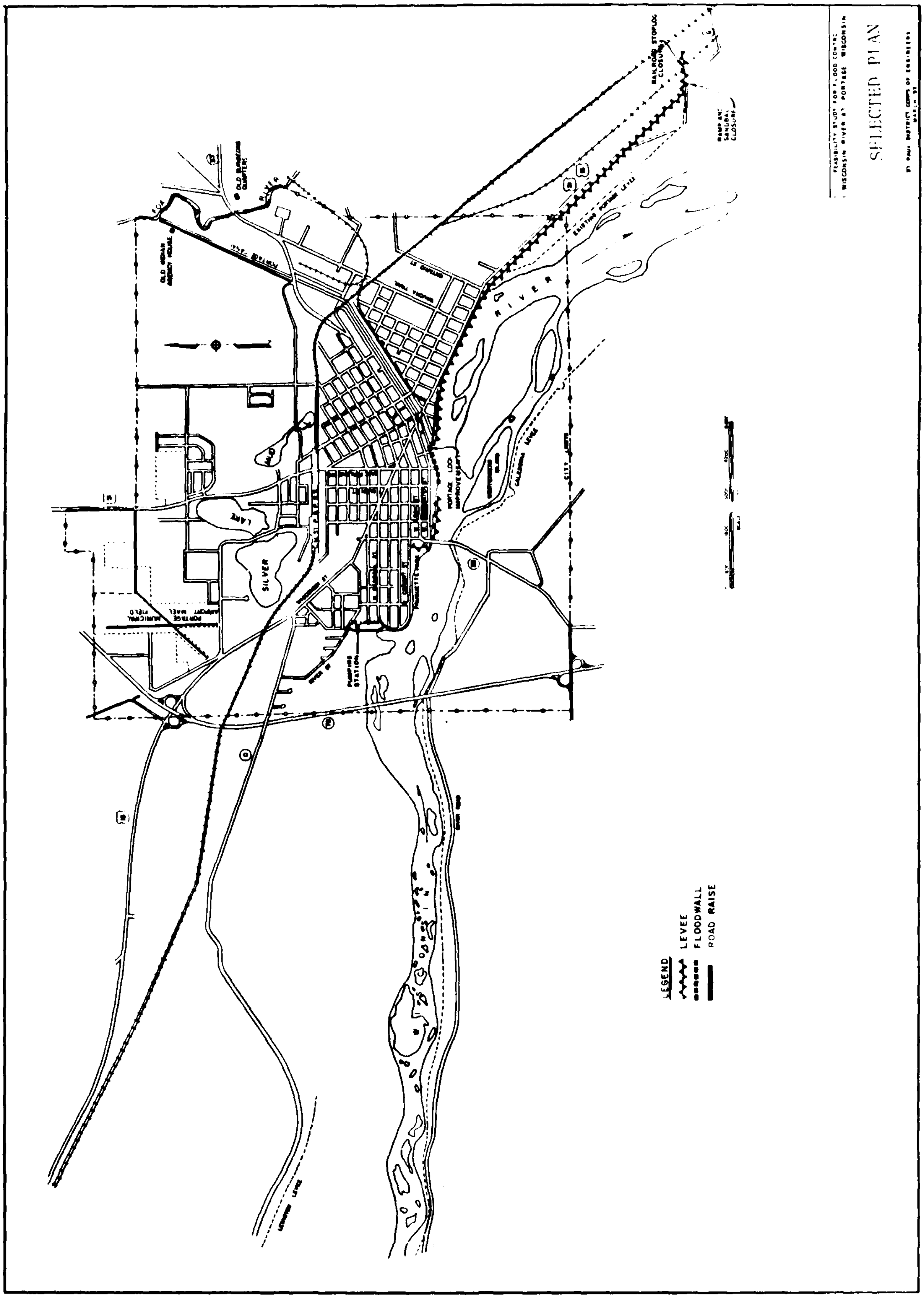
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

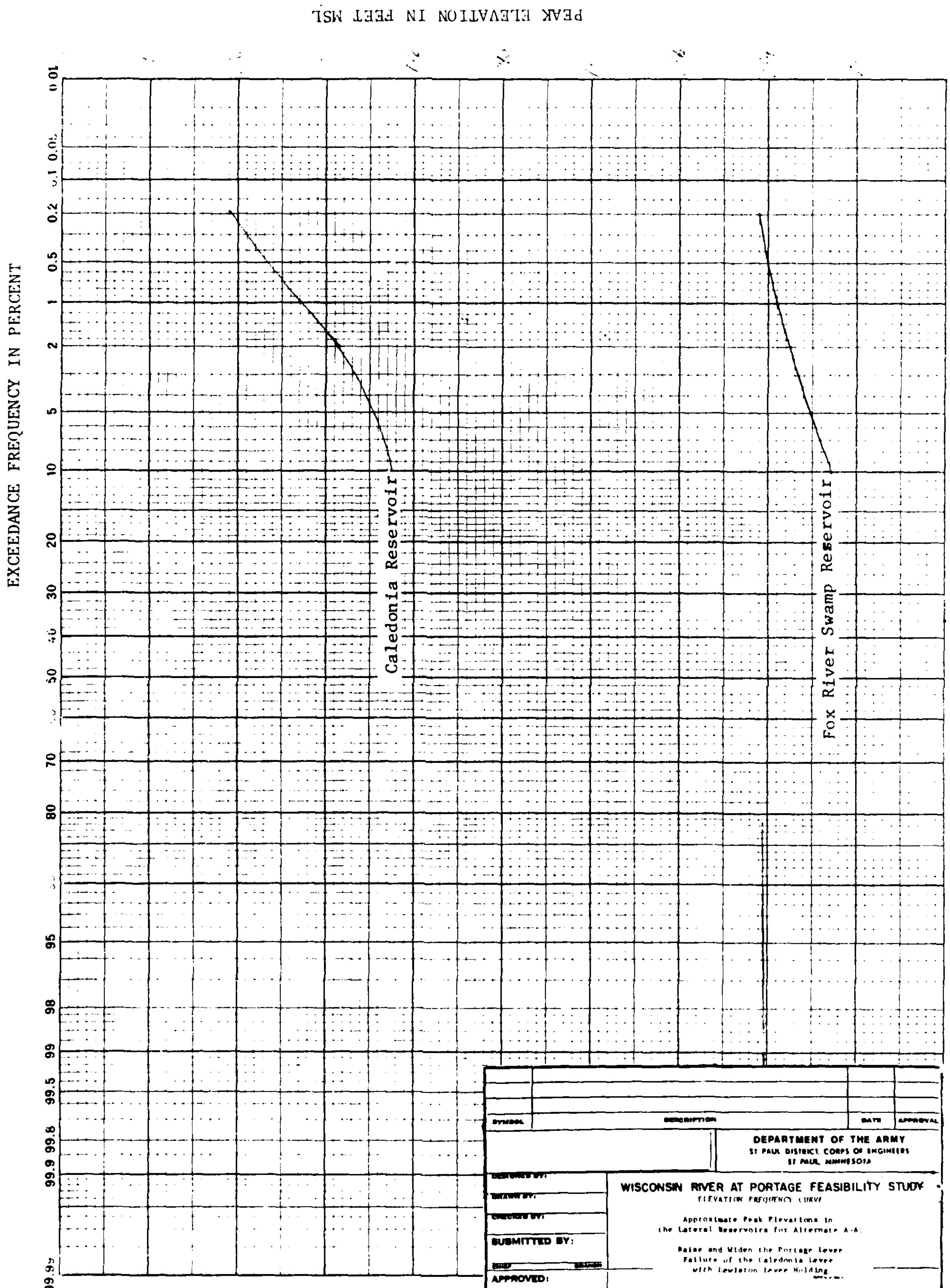
WATER SURFACE PROFILE

ASSUMED LEVEE CONDITION 9

DRAWING NUMBER

PLATE C-96


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE WISCONSIN
SELECTED PLAN
ST PAUL DISTRICT CORPS OF ENGINEERS
LEGEND
LEVEE
FLOODWALL
ROAD RAISE
RAILROAD STOPLOG CLOSURE
RAMPART SANDBAG CLOSURE
RIVER
SILVER
LAKE
PUMPING STATION
OLD INDIAN AGENCY HOUSE
OLD SURGEONS QUARTERS
PORTAGE MUNICIPAL AIRPORT
CITY LIMITS
CALEDONIA LEVEE
PORTAGE LEVEE



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

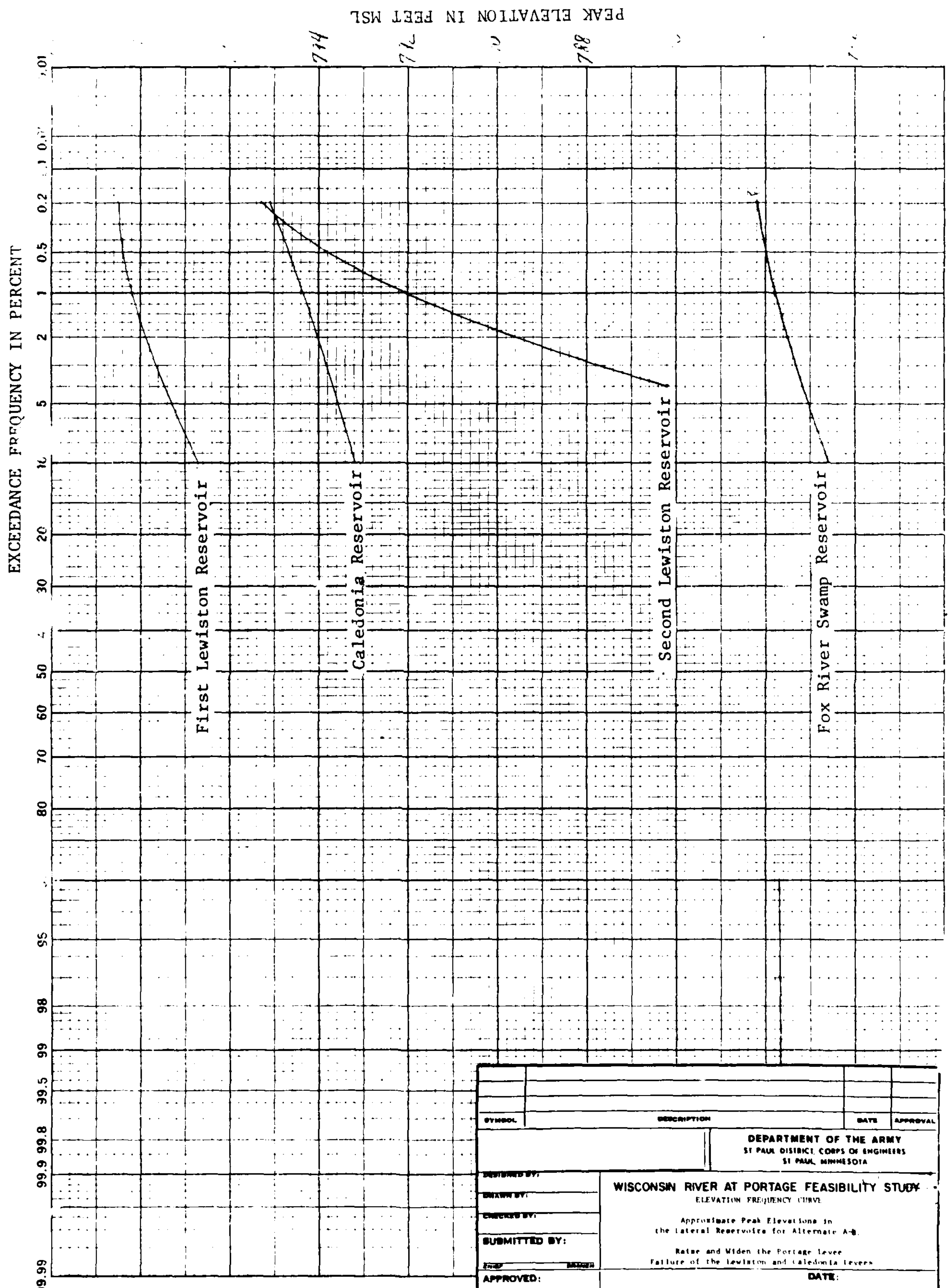
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEVATION FREQUENCY CURVE

Approximate Peak Elevations in
the Lateral Reservoirs for Alternate A-A:

Raise and Widen the Portage Levee
Failure of the Caledonia Levee
with Lewiston Levee Holding

SCALE:
SPEC NO

Plate C-95



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
CHIEF BRANCH
APPROVED:
CHIEF ENGR DIVISION

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEVATION FREQUENCY CURVE

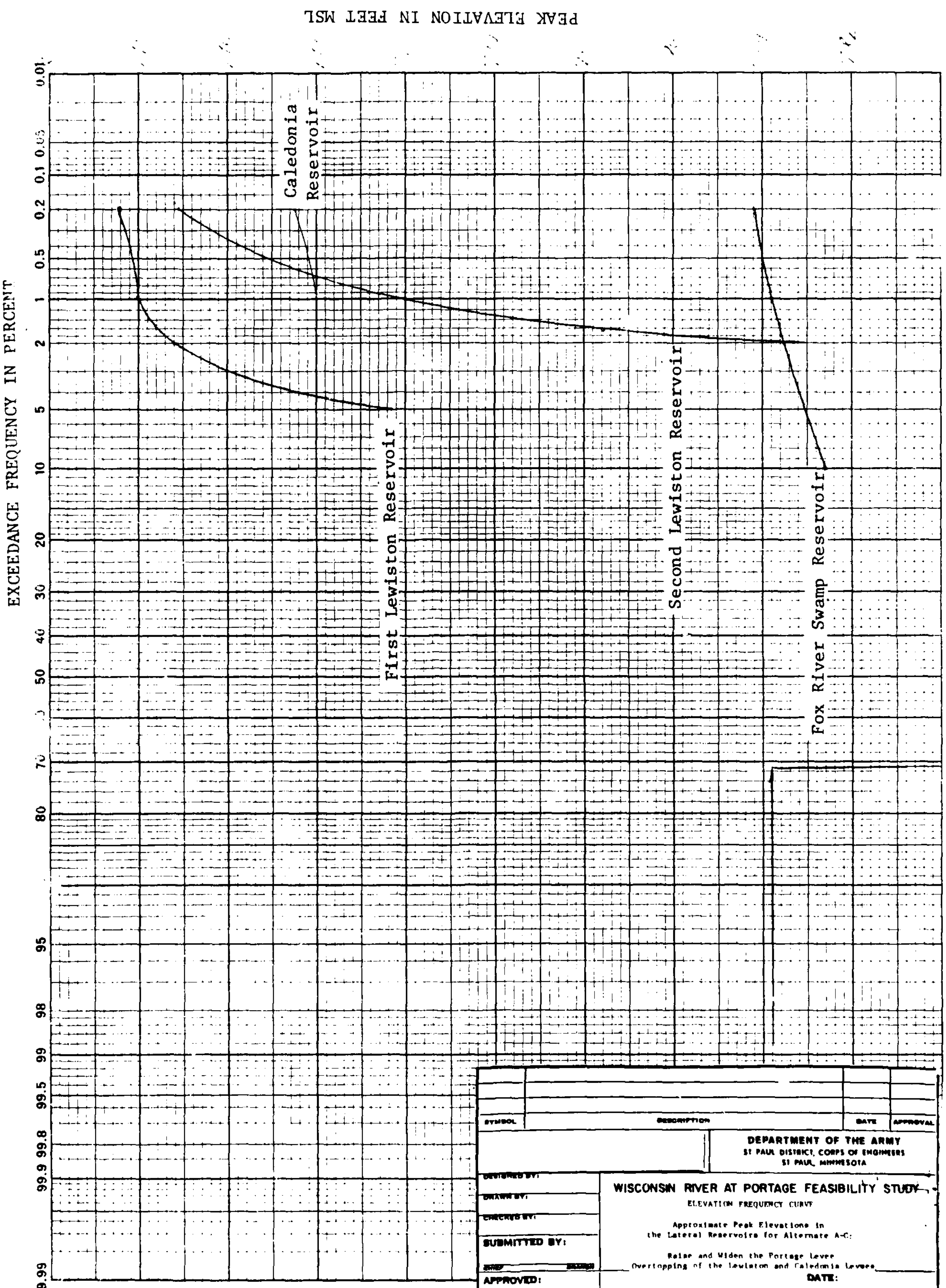
Approximate Peak Elevations in
the Lateral Reservoirs for Alternate A-B.

Raise and Widen the Portage Levee
Failure of the Lewiston and Caledonia Levees

DATE:

SCALE:
SPEC. NO.

Plate C-98



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY:

DRAWN BY:

CHECKED BY:

SUBMITTED BY:

APPROVED:

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY

ELEVATION FREQUENCY CURVE

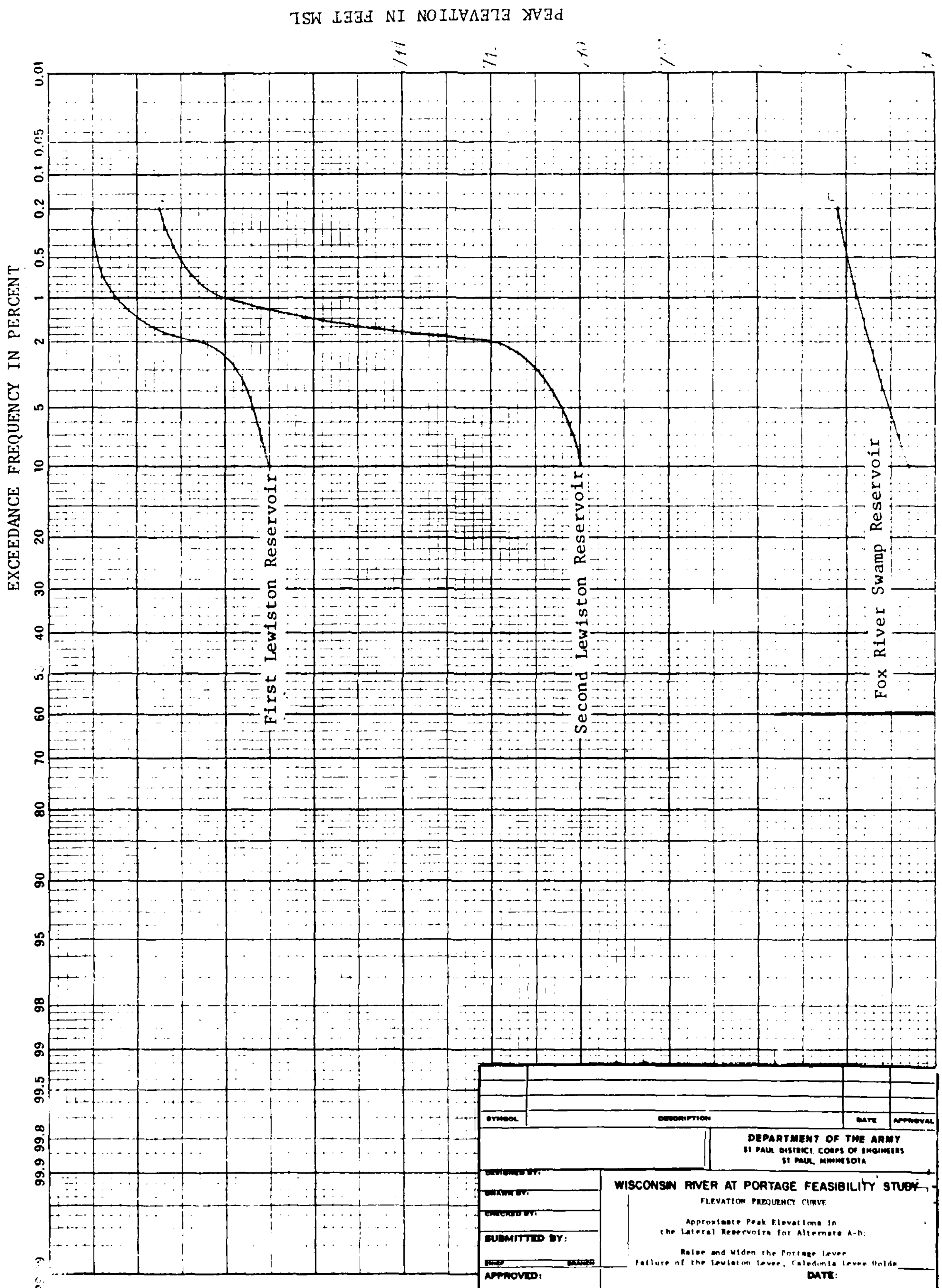
Approximate Peak Elevations in
the Lateral Reservoirs for Alternate A-C:

Raise and Widen the Portage Levee
Overtopping of the Lewiston and Caledonia Levees

DATE:

SCALE:

Plate C-100



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEVATION FREQUENCY CURVE

Approximate Peak Elevations in the Lateral Reservoirs for Alternate A-D:

Raise and Widen the Portage Levee
Failure of the Lewiston Levee, Caledonia Levee Holds

DATE:

SCALE:

Plate C-101

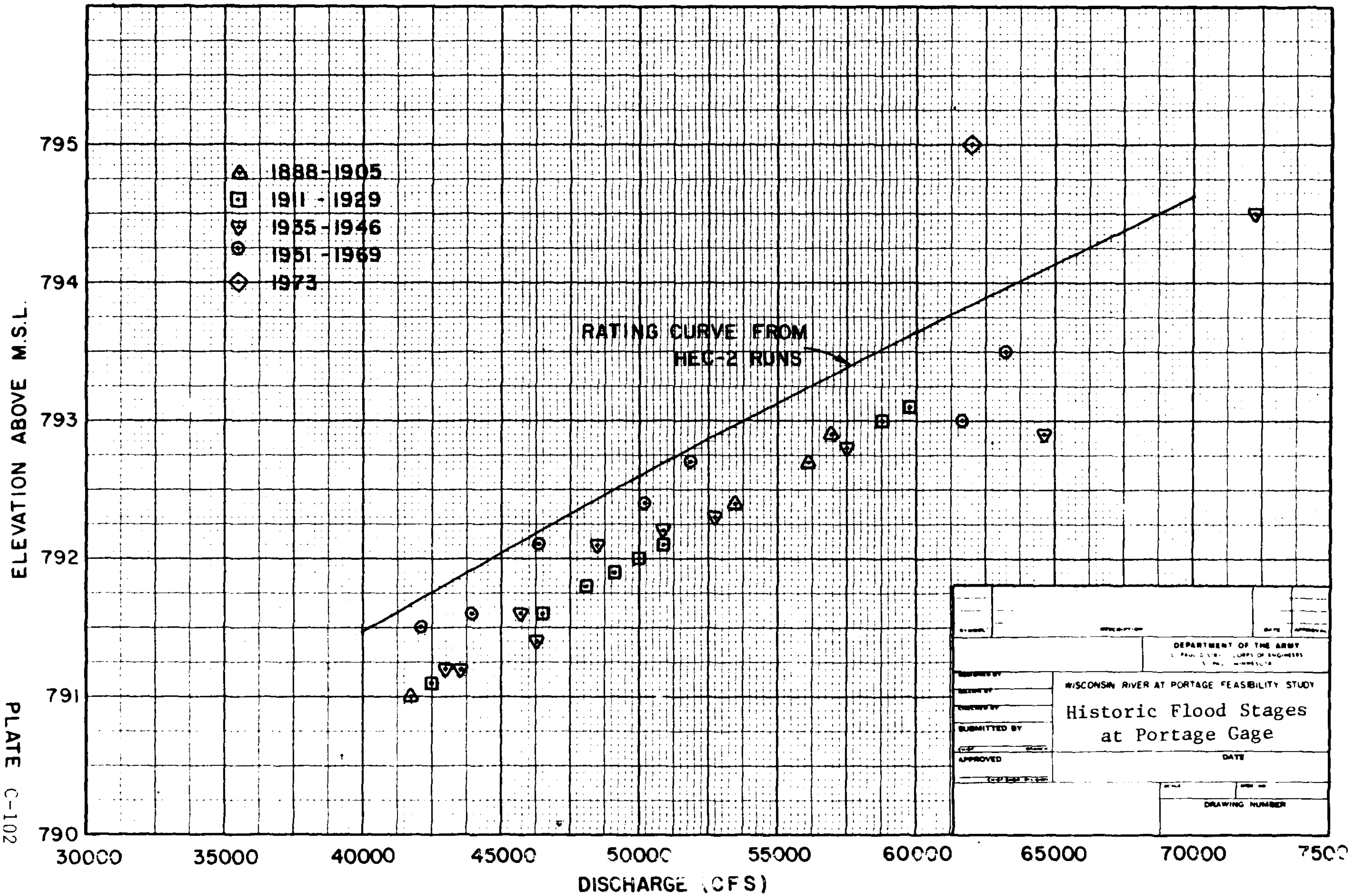
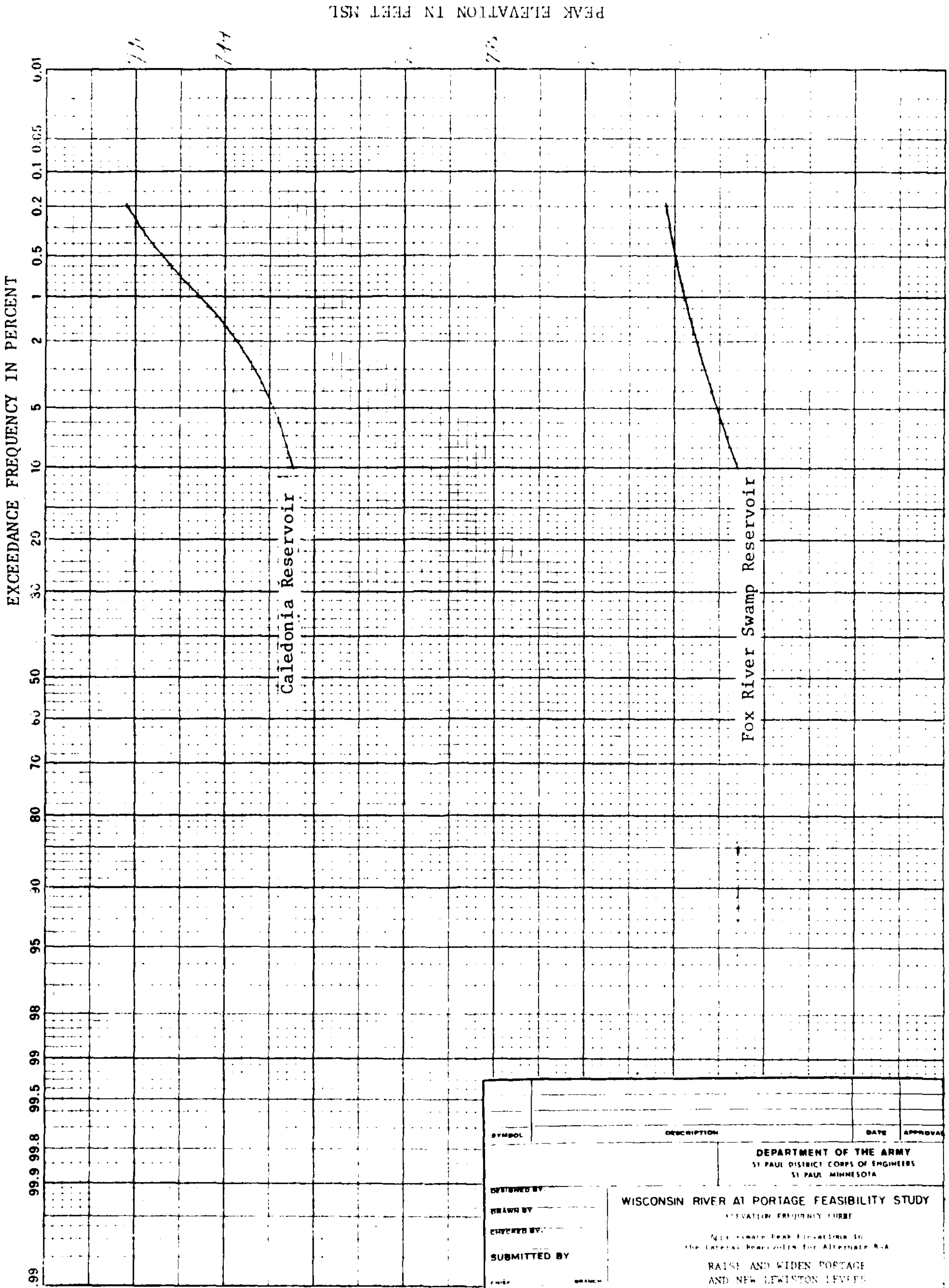

1888-1905
1911 - 1929
1935 - 1946
1951 - 1969
1973
RATING CURVE FROM
HEC-2 RUNS
ELEVATION ABOVE M.S.L.
795
794
793
792
791
790
30000
35000
40000
45000
50000
55000
60000
65000
70000
DISCHARGE (CFS)
DEPARTMENT OF THE ARMY
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
Historic Flood Stages
at Portage Gage
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

PLATE C-102



SYMBOL	DESCRIPTION	DATE	APPROVAL

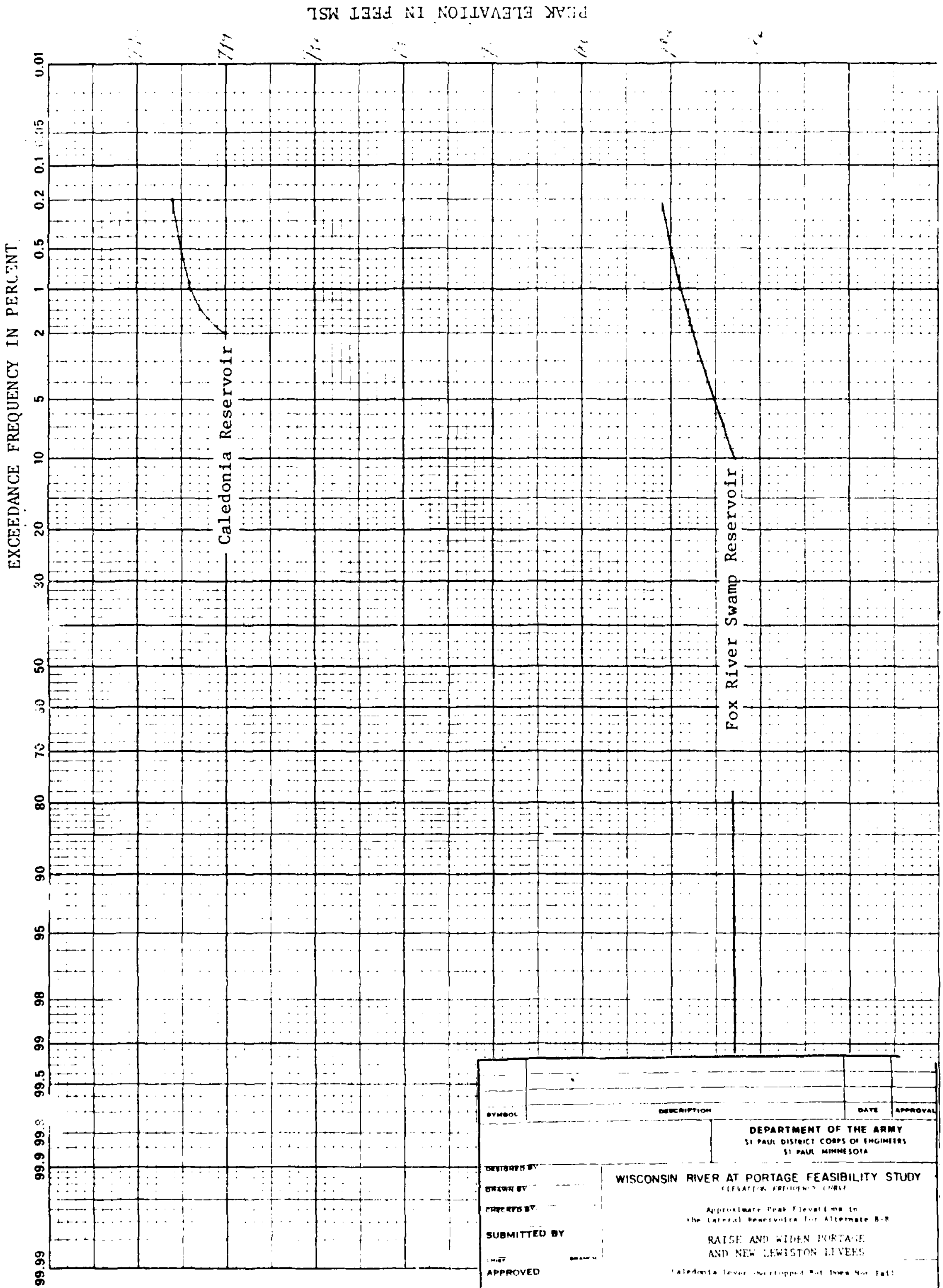
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

DESIGNED BY:
DRAWN BY
CHECKED BY:
SUBMITTED BY
CHIEF BRANCH
APPROVED:
CHIEF ENGR DIVISION

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEVATION FREQUENCY CURVE
Approximate Peak Elevations in the Lateral Reservoirs for Alternate R-A
RAISE AND WIDEN PORTAGE AND NEW LEWISTON LEVEES

SCALE | SHEET NO

C-103



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
CHIEF BRANCH
APPROVED
CHIEF ENGR DIVISION

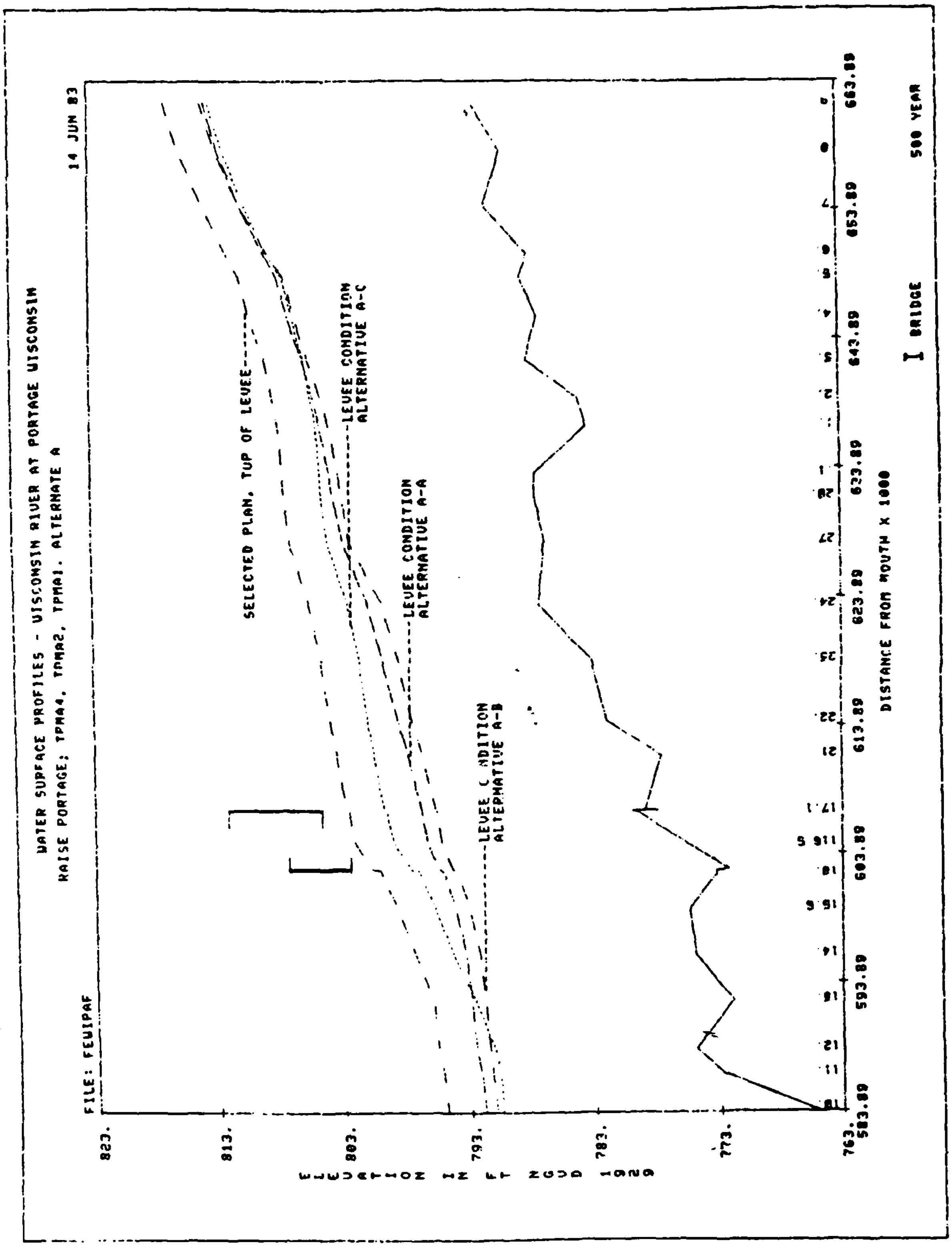
WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY
ELEVATION FREQUENCY CURVE

Approximate Peak Elevations in the Lateral Reservoirs for Alternate B-8

RAISE AND WIDEN PORTAGE AND NEW LEWISTON LEVEES

Caledonia levee Overtopped But Does Not Fail

SCALE
SPEC. NO.



WISCONSIN RIVER AT PORTAGE
FEASIBILITY STUDY
SELECTED 0.2 % CHANCE
FLOOD LEVEL OF PROTECTION
WATER SURFACE PROFILE

PLATE C-105

FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER
at
PORTAGE, WISCONSIN

APPENDIX D

INTERIOR FLOOD CONTROL

December 1983

APPENDIX D

TABLE OF CONTENTS

INTERIOR FLOOD CONTROL

TABLE OF CONTENTS (Cont)

TABLES

PLATES

APPENDIX D

INTERIOR FLOOD CONTROL

PROPOSED INTERIOR FLOOD CONTROL PLAN

The proposed interior flood control plan for Portage, Wisconsin, includes the construction of two gravity outlets, one stormwater pumping station, and one intercepting storm sewer. A 42-inch RCP gated gravity outlet is to be constructed at the city park on Conant and Pierce Streets. Also, 1,100 gpm capacity portable pumping is recommended at this location. A twin 36-inch RCP gated gravity outlet and a 4,000 gpm stormwater pumping station will be constructed at the reach of levee under Summit Street. The proposed 1,000 feet of intercepting storm sewer, located along Cook Street from Cass Street west to the park, will intercept runoff from three existing city storm sewers and carry the runoff to the proposed gated outlet at the city park. All existing outlets under proposed levee reaches will be removed. The location of all major interior drainage features is shown on Plate D-1.

For the purpose of interior flood control design, the proposed levee has been divided into four reaches. Of these four reaches, only A and B require outlets. The runoff from areas protected by levees in Reaches C and D drains towards the Portage Canal and north to the Fox River; therefore, no further interior flood analysis is required for these areas. Also, the potential for Fox River flooding in these areas is very unlikely (see discussion in hydrology appendix). Reach A extends between River Street and Carroll Street; Reach B extends between Conant Street and Dunn Street; Reach C extends from Dunn Street to the Portage locks; and Reach D begins at the Portage locks and extends downstream. (See Plate D-1.)

DESCRIPTION OF WATERSHED AND DRAINAGE PATTERNS

Existing Conditions

Under existing conditions, the runoff from Area A is carried to the river through a 24-inch outlet at Franklin Street and an 18-inch outlet

at Carrol Street. Runoff from Area B is carried to the river through three outlets, an 18-inch outlet at Pierce Street, a 36-inch outlet at Armstrong Street and a 12-inch outlet at Cass Street. Both Areas A and B consist of developed residential land with a moderate to steep slope. Area A is 71 acres and Area B is 61 acres. Watershed boundaries are shown on Plate D-1.

Future Conditions

Since the Areas A and B watersheds are already developed, there should be no significant change in drainage patterns except in Area B where the outflow from the storm sewers at Pierce, Armstrong and Cass Streets will be diverted to the west into the park and thence into the river through the proposed outlet.

Ponding Areas

Ponding areas for both the Pierce Street outlet (Outlet A) and the Franklin Street outlet (Outlet B) are shown on Plate D-1. Elevation storage curves are shown on Plate D-2. Flooded outlines for Areas A and B are shown on plates D-15, D-16, and D-17.

Elevation-Damage Relationship

Elevation-damage curves for Areas A and B are shown on Plate D-3. The zero damage elevations for Areas A and B are 791.0 and 793.0, respectively. Damages are updated to October 1982 price levels.

DESIGN CRITERIA

References

The following references were used in the development of the interior flood control plan.

a. EM 1110-2-1405, Flood Hydrograph Analysis and Computations.

b. EM 1110-2-1410, Interior Drainage of Leveed Urban Areas; Hydrology.

c. EM 1110-2-1411, Standard Project Flood Determinations (Civil Works Engineer Bulletin No. 52-8, March 1952).

d. EM 1110-2-3101, Pumping Stations - Local Cooperation and General Considerations.

e. EM 1110-2-3102, General Principles of Pumping Station Design and Layout.

f. EM 1110-2-3105, Mechanical and Electrical Design of Pumping Stations.

g. EM 1110-345-284 (TM 5 820-4), Drainage for Areas Other than Airfields.

h. National Weather Service Technical Report No. 40, "Rainfall Frequency Atlas of the United States," May 1961.

i. National Weather Service Technical Report No. 49, "Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States," 1964.

j. "Climatological Data," National Oceanic and Atmospheric Administration, Environmental Data Service, U.S. Department of Commerce.

k. "Hourly Precipitation Data," National Oceanic and Atmospheric Administration, Environmental Data Service, U.S. Department of Commerce.

l. "Water Resources Data for Wisconsin," U.S. Department of the Interior, Geological Survey.

m. Soil Conservation Service Technical Release No. 55, "Urban Hydrology for Small Watersheds," January 1975.

n. "Guidelines for Determining Flood Flow Frequencies," Bulletin No. 17 of the Hydrology Committee, March 1976, U.S. Water Resources Council.

o. "Flood Control, Minnesota River, Minnesota, Mankato-North Mankato-LeHillier, Design Memorandum No. 7 - Mankato Stage 3C," Department of the Army, St. Paul District Corps of Engineers, St. Paul, Minnesota, September 1981.

River Discharge and Stage Data

Elevation discharge rating curves at the two outlets were developed from HEC-2 backwater profiles assuming levee condition 1 (all flow confined within the levees) as described in Appendix C. Rating curves are shown on Plates D-4 and D-5. The U.S. Geological Survey (USGS) has a

continuous record since 1934 of daily discharges on the Wisconsin River at Wisconsin Dells, located approximately 17 miles upstream of Portage, Wisconsin. Only local inflow occurs between Wisconsin Dells and Portage and, therefore, the discharge-frequency relations at the Wisconsin Dells gage also are appropriate to use for Portage, Wisconsin. The discharge-duration relation for the Wisconsin Dells gage representing the period 1935-1980 was used with the elevation-discharge rating curve at Outlet B to develop an elevation-duration curve as shown on Plate D-6.

Rainfall Data

The 1/2-hour, 1-hour, 6-hour, 48-hour and 96-hour duration rainfall depths for the 50-, 20-, 10-, 4-, 2- and 1-percent chance exceedence theoretical all-year rainfall events in the Portage area were obtained from U.S. Weather Bureau Technical Reports No. 40 and No. 49 (references h. and i.). The standard project storm for the Portage area was developed in accordance with EM 1110-2-1411 (reference c.). Theoretical rainfall data are shown in Table D-1. In addition to hypothetical storm events, an analysis was performed of historical rainfall events. Historical rainfall data were obtained from the U.S. Department of Commerce publication "Climatological Data" (reference j.). Daily precipitation data were obtained for the gage at Portage from 1936-1980. Hourly precipitation data at Portage were available from 1951-1980.

Runoff Hydrographs

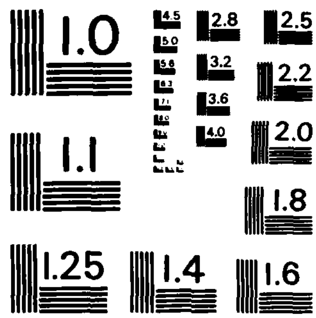
Rainfall runoff hydrographs for Areas A and B were developed for the 50-, 20-, 10-, 4-, 2- and 1-percent chance exceedence and standard project all-year theoretical storms. Unit hydrographs were developed using the SCS method using the HEC-1 computer program. The input values to the HEC-1 computer program are shown in Table D-2. Lag time (L) was calculated using the following formula, found in Soil Conservation Service

TABLE D-1
THEORETICAL RAINFALL

TIME IN HOURS		RETURN PERIOD IN YEARS 2	5	10	25	50	100	SPS
0	10	0.01	0.01	0.01	0.01	0.02	0.02	0.01
0	20	0.01	0.01	0.01	0.02	0.02	0.02	0.01
0	30	0.01	0.01	0.02	0.02	0.02	0.02	0.01
0	40	0.01	0.01	0.02	0.02	0.02	0.03	0.01
0	50	0.01	0.02	0.02	0.02	0.03	0.03	0.02
1	00	0.01	0.02	0.02	0.03	0.03	0.03	0.02
1	10	0.01	0.02	0.02	0.03	0.03	0.04	0.02
1	20	0.01	0.02	0.03	0.03	0.04	0.04	0.02
1	30	0.02	0.02	0.03	0.04	0.04	0.05	0.03
1	40	0.02	0.03	0.03	0.04	0.04	0.05	0.03
1	50	0.02	0.03	0.03	0.04	0.04	0.05	0.03
2	00	0.02	0.03	0.04	0.04	0.05	0.05	0.04
2	10	0.03	0.04	0.04	0.05	0.06	0.07	0.04
2	20	0.03	0.05	0.06	0.07	0.08	0.08	0.05
2	30	0.05	0.07	0.08	0.10	0.11	0.13	0.07
2	40	0.06	0.09	0.10	0.12	0.16	0.14	0.08
2	50	0.13	0.17	0.20	0.24	0.26	0.29	0.08
3	00	0.27	0.36	0.41	0.48	0.54	0.59	0.10
3	10	0.59	0.77	0.91	1.07	1.18	1.30	0.11
3	20	0.14	0.17	0.21	0.24	0.27	0.29	0.12
3	30	0.07	0.09	0.11	0.14	0.13	0.17	0.12
3	40	0.06	0.07	0.08	0.11	0.12	0.13	0.13
3	50	0.05	0.07	0.08	0.10	0.10	0.12	0.14
4	00	0.03	0.04	0.04	0.05	0.06	0.07	0.15
4	10	0.02	0.03	0.04	0.05	0.06	0.06	0.15
4	20	0.02	0.03	0.03	0.04	0.05	0.05	0.17
4	30	0.02	0.03	0.03	0.04	0.04	0.05	0.17
4	40	0.02	0.03	0.03	0.04	0.04	0.05	0.18
4	50	0.02	0.02	0.03	0.03	0.04	0.04	0.20
5	00	0.01	0.02	0.02	0.03	0.03	0.04	0.21
5	10	0.01	0.02	0.02	0.03	0.03	0.03	0.23
5	20	0.01	0.02	0.02	0.03	0.03	0.03	0.38
5	30	0.01	0.01	0.02	0.02	0.02	0.03	0.42
5	40	0.01	0.01	0.02	0.02	0.02	0.03	0.46
5	50	0.01	0.01	0.01	0.02	0.02	0.02	0.53
6	00	0.01	0.01	0.01	0.02	0.02	0.02	0.57
6	10	0	0.00	0.00	0.00	0.00	0.00	1.44
6	20	0	0.00	0.00	0.00	0.00	0.00	0.57
6	30	0	0.00	0.00	0.00	0.00	0.00	0.53
6	40	0	0.00	0.00	0.00	0.00	0.00	0.46
6	50	0	0.00	0.00	0.00	0.00	0.00	0.42
7	00	0	0.00	0.00	0.00	0.00	0.00	0.38
7	10	0	0.00	0.00	0.00	0.00	0.00	0.23
7	20	0	0.00	0.00	0.00	0.00	0.00	0.21
7	30	0	0.00	0.00	0.00	0.00	0.00	0.18
7	40	0	0.00	0.00	0.00	0.00	0.00	0.17
7	50	0	0.00	0.00	0.00	0.00	0.00	0.17
8	00	0	0.00	0.00	0.00	0.00	0.00	0.15
8	10	0	0.00	0.00	0.00	0.00	0.00	0.15
8	20	0	0.00	0.00	0.00	0.00	0.00	0.14
8	30	0	0.00	0.00	0.00	0.00	0.00	0.14
8	40	0	0.00	0.00	0.00	0.00	0.00	0.13
8	50	0	0.00	0.00	0.00	0.00	0.00	0.12
9	00	0	0.00	0.00	0.00	0.00	0.00	0.11
9	10	0	0.00	0.00	0.00	0.00	0.00	0.11
9	20	0	0.00	0.00	0.00	0.00	0.00	0.09
9	30	0	0.00	0.00	0.00	0.00	0.00	0.08
9	40	0	0.00	0.00	0.00	0.00	0.00	0.07
9	50	0	0.00	0.00	0.00	0.00	0.00	0.06
10	00	0	0.00	0.00	0.00	0.00	0.00	0.04
10	10	0	0.00	0.00	0.00	0.00	0.00	0.04
10	20	0	0.00	0.00	0.00	0.00	0.00	0.03
10	30	0	0.00	0.00	0.00	0.00	0.00	0.03
10	40	0	0.00	0.00	0.00	0.00	0.00	0.03
10	50	0	0.00	0.00	0.00	0.00	0.00	0.02
11	00	0	0.00	0.00	0.00	0.00	0.00	0.02
11	10	0	0.00	0.00	0.00	0.00	0.00	0.02
11	20	0	0.00	0.00	0.00	0.00	0.00	0.02
11	30	0	0.00	0.00	0.00	0.00	0.00	0.01
11	40	0	0.00	0.00	0.00	0.00	0.00	0.01
11	50	0	0.00	0.00	0.00	0.00	0.00	0.01
12	00	0	0.00	0.00	0.00	0.00	0.00	0.01

AD-A148 351 FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT WISCONSIN RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 83 5/9

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Technical Release No. (TR) 55 (reference m.) as equation 3-2:

$$L = \frac{\ell^{0.8} (S + 1)^{0.7}}{1900\ Y^{0.5}}$$

where:

L = lag in hours

ℓ = hydraulic length of watershed in feet

$S = \frac{1000}{CN} - 10$ (CN is the SCS curve number)

Y = average watershed land slope in percent

TABLE D-2

UNIT HYDROGRAPH DATA

	Area A Watershed	Area B Watershed
Drainage Area	71 acres	61 acres
AMC III Curve Number	88	88
Length of Drainage Path	2,850 ft.	2,200 ft.
Average slope along path	2.2%	1.6%
Lag Time	.38 hrs.	.36 hrs.

The input parameters were developed using city street and storm sewer maps and 2-foot contour interval topographical maps. The unit hydrographs and runoff hydrographs are presented in Tables D-3 and D-4.

Peak runoff rates for subbasins located along the proposed intercepting storm sewer in Area B were obtained using the following drainage area comparison formula:

$$Q_S = (A_S/A)^n\ Q$$

TABLE D-3
RAINFALL RUNOFF HYDROGRAPHS FOR THE AREA A WATERSHED
ALL YEAR RAINFALL EVENTS

TIME IN HOURS	PERCENT CHANCE EXCEEDENCE 50	20	10	4	2	1	SPS
0.5	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0
2.0	0	0	0	0	0	1	0
2.5	0	0	2	4	5	8	1
3.0	7	15	21	31	39	44	8
3.5	62	98	125	157	181	203	19
4.0	29	43	54	69	76	88	32
4.5	13	19	21	29	32	37	47
5.0	9	13	14	18	20	25	65
5.5	5	9	10	13	14	16	99
6.0	4	5	8	10	10	12	173
6.5	2	2	2	4	4	4	319
7.0	0	0	0	1	1	1	224
7.5	0	0	0	0	0	0	135
8.0	0	0	0	0	0	0	86
8.5	0	0	0	0	0	0	67
9.0	0	0	0	0	0	0	58
9.5	0	0	0	0	0	0	47
10.0	0	0	0	0	0	0	33
10.5	0	0	0	0	0	0	19
11.0	0	0	0	0	0	0	13
11.5	0	0	0	0	0	0	9
12.0	0	0	0	0	0	0	5
12.5	0	0	0	0	0	0	2
13.0	0	0	0	0	0	0	0
13.5	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0

TABLE D-4

RAINFALL RUNOFF HYDROGRAPHS FOR THE AREA 3 WATERSHED
ALL YEAR RAINFALL EVENTS

TIME IN HOURS	PERCENT CHANCE EXCEEDENCE 50	20	10	4	2	1	SPS
0.5	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0
2.0	0	0	0	0	0	1	0
2.5	0	0	1	4	5	7	1
3.0	7	14	19	28	35	40	7
3.5	54	65	109	137	157	177	17
4.0	23	35	44	56	62	72	28
4.5	10	16	17	24	26	30	41
5.0	8	11	12	15	16	19	55
5.5	5	6	8	11	12	13	87
6.0	4	5	6	8	8	10	151
6.5	1	2	2	3	3	3	277
7.0	0	0	0	0	0	1	168
7.5	0	0	0	0	0	0	112
8.0	0	0	0	0	0	0	71
8.5	0	0	0	0	0	0	57
9.0	0	0	0	0	0	0	49
9.5	0	0	0	0	0	0	39
10.0	0	0	0	0	0	0	27
10.5	0	0	0	0	0	0	16
11.0	0	0	0	0	0	0	11
11.5	0	0	0	0	0	0	6
12.0	0	0	0	0	0	0	5
12.5	0	0	0	0	0	0	2
13.0	0	0	0	0	0	0	0
13.5	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0

Where:

Q_S = discharge of subarea

Q = discharge of hydrograph for area being compared to

A_S = size of subarea in acres

A = size of area for which hydrograph was computed

n = drainage area exponent (use 0.6)

Seepage and Snowmelt

The estimated peak seepage rate along the Reach A levee based on the design river stage of 799.1 and a 9.1-foot head is about 3,000 gpm or about 330 gpm per foot of head. The estimated peak seepage rate along the Reach B levee based on the design river stage of 797.6 and a 7.6-foot head, is about 1,050 gpm or about 140 gpm per foot of head. In the pond stage frequency analysis, seepage is assumed to occur whenever the gates are closed and the river stage exceeds the minimum ground or interior water surface elevations. Snowmelt runoff is considered to be insignificant.

GRAVITY FLOW DESIGN

Gravity Outlet and Stormwater Intercepting Sewers

Elevation-discharge rating curves for the proposed outlets are shown on Plates D-7 and D-8. The location of the intercepting sewer is shown on Plate D-1.

The design of the intercepting sewers and the gravity outlets is based on the criteria presented in TM 5-820-4 (reference g.) based on the inflow from a 50-year storm and a river elevation of 786.0 for both outlets.

The design discharge for the interceptors was determined by applying the drainage area formula, presented earlier for each contributing subbasin. Both the gravity outlets and the intercepting sewers are to be reinforced concrete pipe. Manning's roughness coefficient is assumed as .014, and the entrance loss coefficient used is assumed to be 0.5 for the outlets and 0.2 for the intercepting sewers.

Performance of Proposed Stormwater Sewerage System

Tables D-5, D-6, D-7, and D-9 show maximum pond levels and resulting damages which would have occurred in levee Reaches A and B for the most severe historical rainfall events between 1934 and 1980 and/or for the 50-, 25-, 10-, 4-, 2- and 1-percent chance exceedence and standard project theoretical storms. The maximum pond levels were obtained by routing the hydrographs shown in Tables D-3 and D-4 through the proposed gravity outlets. The Wisconsin River stages indicated are based on the average river flow during the selected rainfall event and corrected to stage based on the stage-discharge curves shown on Plates D-4 and D-5.

TABLE D-5

MAXIMUM POND LEVELS FOR THEORETICAL STORMS
AREA A
TWO - 36-INCH RCP OUTLETS

Event	Maximum Pond Elevation	Damage in Thousand Dollars	Peak Outflow
2-percent	790.9	0	69 cfs
1-percent	791.2	10	78 cfs
SPS	794.3	105	148 cfs

TABLE D-6

MAXIMUM POND LEVELS FOR HISTORICAL STORMS
AREA B
ONE - 42-INCH RCP OUTLET

Event			No Pumping		600 GPM	
Year	Day From	Day To	Maximum Pond Elevation	Damage in Thousand Dollars	Maximum Pond Elevation	Damage in Thousand Dollars
1973	16 Apr	25 Apr	793.4	450	791.6	0
1972	16 May	2 Jun	792.6	0	791.4	0
1960	8 Apr	17 Apr	793.2	425	791.5	0
1951	15 Apr	26 Apr	793.1	400	791.3	0
1938	10 Sep	24 Sep	793.6	465	792.8	0

TABLE D-7

AREA B - NO PUMPING

MAXIMUM POND LEVEL FOR THEORETICAL STORMS
AREA B
NO PUMPING

River Stage	50	20	10	4	2	1	SPS
792.9	793.4	793.6	793.8	793.9	794.0	794.2	795.9
790.7	791.2	791.5	791.7	791.9	792.1	792.3	794.2
788.7	789.7	789.8	790.1	709.4	790.6	790.8	793.1
786.4	788.4	789.1	789.6	790.2	790.4	790.6	793.0

DESIGN OF PUMPING STATION

A new 4,000 gpm stormwater pumping station equipped with two 2,000 gpm pumps will be located at Outlet A. No pumping station is recommended for Outlet B. The selected gate closure elevation at both outlets is 790.0.

PUMPING REQUIREMENTS AT OUTLET B

A probabilistic rainfall streamflow analysis was performed for Outlet B. The analysis assumed the gravity outlet would be reopened when the interior pond level exceeds the selected river stage by 1 foot. At the selected gate closure elevation of 790.0, the flow in the river is 22,000 cfs, which has a frequency of occurrence of once every 1.3 years or about 2.9 percent of the time.

The initial step in performing the probabilistic rainfall-streamflow analysis is to prepare a stage-duration curve as shown on Plate D-6, subdivide the area beneath the curve into an appropriate number of sections, and obtain the average river stage for each section. As shown on Plate D-6, the area beneath the curve has been divided into four sections representing 1.1, 1.9, 5.0 and 92 percent duration. The average river stages at Outlet B for each of these areas are 792.9, 790.7, 788.7 and 783.6, respectively.

Maximum Pond Levels

Maximum pond levels presented in Table D-7 were based on the combination of the above river stages and all-year rainfall events having a frequency of occurrence of about 50, 20, 10, 4, 2 and 1 percent. Elevation-storage capacity relationships adjacent to Outlet B are shown on Plate D-2. Hypothetical hyetographs and runoff hydrographs for the above all-year rainfall events are presented in Tables D-3 and D-4, respectively. Elevation discharge curves for the proposed 42-inch gravity outlet are shown on Plate D-8.

Total inflow to the pumping station consists of rainfall excess and seepage; snowmelt is not included. Seepage was assumed to occur prior to the commencement of the selected rainfall event. To account for seepage, the starting pond level was assumed to be the same as the selected river elevation. The selected rainfall events were then routed through the gravity outlet.

Pond Level Frequency Relationships

The pond level frequency relationships based on the selected river stages and rainfall events are presented on Plate D-9. The curves were obtained by plotting the maximum pond levels against the rainfall frequency values obtained from Table D-7.

Pond Level Exceedence Probabilities

The combined pond level exceedence probabilities for various interior pond levels based on the four selected river stages, six rainfall events and a no-pumping condition are shown in Table D-8. The frequency of occurrence for the various pond levels was obtained by multiplying the frequencies from Plate D-9 times the selected river stage duration, and totaling these values for each of the four selected river stages. The values were then multiplied by 100 to obtain the percent chance of occurrence. The damages shown in Table D-8 were obtained from the damage-elevation curve shown on Plate D-3 and represent damages at the selected pond level.

Damage-Frequency Curves

A damage-frequency curve for the no-pumping condition is presented on Plate D-10. The average annual damage which is equal to the area under the curve is $4,000.

TABLE D-8

MAXIMUM POND LEVEL FOR THEORETICAL STORMS
AREA B
POND LEVEL EXCEEDENCE PROBABILITIES

NO PUMPING

River Stage	783.6	788.7	790.7	792.9		
Duration	.92	.050	.019	.011	Total	Damages
Pond Level						
788.5	.45	1	1	1	.494	0
789.0	.24	1	1		.301	0
789.5	.125	.97	1	1	.194	0
790.0	.06	.13	1	1	.091	0
790.5	.001	.030	.95	1	.032	0
791.0	.0001	.0040	.67	1	.024	0
791.5	-	.0004	.20	1	.015	0
792.0	-	-	.030	1	.012	0
792.5	-	-	.004	1	.011	0
793.0	-	-	.0004	.95	.0105	0
793.5	-	-	-	.33	.0036	$460,000
794.0	-	-	-	.020	.00022	$505,000
794.5	-	-	-	.003	.00003	$560,000
795.0	-	-	-	.0002	-	-

Economic Evaluation

Since the occurrence of any damages without a pumping station is such a rare event, no permanent pumping station is recommended for Area B. However, as shown in Table D-6, damage would have occurred for some historical floods without pumping but, with portable pumping of 600 gpm, those damages could be prevented. To remove the peak seepage of 1,050 gpm under a design river level of 797.6 feet, portable pumping of 1,100 gpm is required.

Future Considerations

The reliability of the portable pump will be given additional consideration in postauthorization studies. Specifically, items to be addressed include identification of the type and location of a pump storage facility, the establishment of a procedure to put the pump into use, the availability of a power source for pump operation, and a maintenance program for keeping the pump operational. Quite likely, the city would store the pump in the water department building located a few hundred feet from the ponding area, operate the pump from electricity within the park area, and utilize an implementation/maintenance plan similar to what is followed under emergency conditions.

PUMPING REQUIREMENTS AT OUTLET A

The required capacity of a pumping station at Outlet A was determined based on a standard period of record analysis for the 45-year period from 1936-1980. Pump rates of 1,000, 1,500, 2,250 and 3,000 gpm were combined with a gate closure elevation of 790. After the gates were closed, the pond was pumped down to elevation 789.0. The pumping station was assumed to have two pumps of equal capacity with the first pump starting at elevation 789.5, the second pump starting at elevation 790.0, the first pump then turns off when the pond level recedes to elevation 789.5, and the second pump turns off at elevation 789.0. A probabilistic-economic analysis was not considered because of the large volume of seepage anticipated in Reach A.

The need for a pumping station in Area A based on the indicated period of record, pumping rates and selected gate closure elevation is summarized in Table D-9. The period of blocked gravity drainage indicated in the table includes all periods from 1936 through 1980 during which the river stage at Outlet B exceeded elevation 790.0. The maximum river stages indicated in the table are the maximum stages reached during each period of blocked gravity drainage.

The estimated volume of inflow indicated in Table D-9 is the sum of all rainfall excess and seepage which occurred during the selected period. The rainfall values are based on the recorded amounts at Portage. Rainfall excess amounts, unless otherwise indicated, are based on an excess rate of 70 percent during the month of March and 60 percent during the months of April through October, inclusive. The estimated rate of seepage is discussed earlier.

The maximum pond elevations reached during each period of blocked gravity drainage, with and without pumping, were estimated by routing all inflow through the ponding areas, opening the gravity outlets when the pond level reaches an elevation of 1 foot above the river stage, and starting and stopping pumping operations at the selected levels. Routings were performed on a daily basis unless there was an intense rainfall which resulted in inflow rates greater than the selected pumping rate. In this case, routings were performed on a half-hour basis and the rainfall excess was based on an infiltration rate of .5 inch during the first hour and 0.05 inch during each additional hour. In cases where the pond level exceeds the river stage by 1 foot, it is assumed the gates at Outlet A will be temporarily opened until the interior pond level recedes to the level of the river. Then the gates would be closed again.

The estimated damages indicated in Table D-9 are based on the maximum pond level reached during each period of blocked gravity drainage and the elevation damage curve for Reach A. The estimated benefits developed with each selected pumping rate are equal to the difference between the amount of damages with and without pumping.

TABLE D-9

MAXIMUM POND LEVELS FOR HISTORICAL STORMS

AREA A

Period of Blocked Gravity Drainage				Max. River Stage during Period	Total Rainfall Inflow during Period			See-page in Acre Feet	Total In-flow Acre Feet	Maximum Pond Elevation				Damages in Thousand Dollars			
						Excess											
Year	No. of Days	From	To		Inches	Inches	Ac.-Ft.			Without Pumping	1000 GPM	2250 GPM	3000 GPM	Without Pumping	1000 GPM	2250 GPM	3000 GPM
1980	6	22 Sep	27 Sep	794.6	1.52	.91	5.41	7.8	13.2	793.5	791.2	790.0	790.0	90	10	0	0
1980	6	6 Jun	11 Jun	794.5	1.50	.90	5.35	6.2	11.5	793.1	790.0	790.0	790.0	80	0	0	0
1979	14	23 Mar	5 Apr	793.2	2.31	1.62	9.63	2.74	12.4	793.3	790.0	790.0	790.0	80	0	0	0
1976	12	25 Mar	5 Apr	794.1	1.60	1.12	6.65	7.1	13.8	793.6	790.0	790.0	790.0	90	0	0	0
1975	11	23 Apr	3 May	793.4	2.47	1.48	8.81	3.4	12.2	793.3	790.3	790.0	790.0	80	0	0	0
1973	15	8 Mar	22 Mar	797.0	2.37	1.66	9.86	17.8	27.7	796.0	793.5	790.4	790.1	130	90	0	0
1973	11	15 Apr	25 Apr	796.0	2.73	1.64	9.73	15.1	24.9	795.6	793.4	790.7	790.2	125	85	0	0
1973	8	26 May	2 Jun	793.9	1.70	1.02	6.06	5.8	11.9	793.2	790.3	790.0	790.0	80	0	0	0
1972	9	26 Sep	4 Oct	794.3	.32	.19	1.13	12.5	13.6	793.6	790.0	790.0	790.0	90	0	0	0
1972	12	15 Apr	26 Apr	794.3	1.41	.85	5.04	13.0	18.1	794.5	792.1	790.2	790.0	105	50	0	0
1971	13	6 Apr	18 Apr	793.3	1.74	1.05	6.21	7.8	14.0	793.7	793.7	790.0	790.1	90	15	0	0
1969	8	23 Jun	30 Jun	794.7	2.48	1.49	8.85	5.2	14.1	793.7	790.0	790.0	790.0	90	0	0	0
1968	12	24 Jun	5 Jul	793.9	2.68	1.61	9.57	2.7	12.2	793.3	790.0	790.0	790.0	80	0	0	0
1967	16	30 Mar	14 Apr	795.6	.94	.57	3.36	13.9	17.3	794.3	791.8	790.0	790.1	105	40	0	0
1965	18	13 Apr	30 Apr	795.0	1.91	1.15	6.82	7.0	13.8	793.6	790.0	790.0	790.0	90	0	0	0
1960	18	16 May	2 Jun	797.1	1.32	.79	4.69	19.8	24.5	795.5	793.3	790.6	790.1	125	85	0	0
1959	7	27 Sep	3 Oct	794.4	.32	.19	1.13	9.4	10.5	792.9	790.0	790.0	790.0	75	0	0	0
1951	10	8 Apr	17 Apr	796.6	1.23	.74	4.38	18.9	23.3	795.4	793.0	790.1	790.1	120	75	0	0
1946	12	15 Mar	26 Mar	794.9	.39	.27	1.60	13.9	15.5	794.0	790.1	790.0	790.0	100	0	0	0
1945	14	18 Mar	1 Apr	794.4	.94	.66	3.92	13.5	17.4	793.4	790.0	790.0	790.0	85	0	0	0
1943	10	31 May	9 Jun	796.4	1.13	.68	4.04	14.5	18.5	794.6	792.2	790.0	790.0	110	50	0	0
1943	18	30 Mar	17 Apr	795.4	.24	.15	.89	14.3	15.2	793.9	790.1	790.0	790.0	95	0	0	0
1942	12	1 Jun	12 Jun	795.8	4.08	2.45	14.6	1.5	16.1	793.5	792.2	790.1	790.1	90	50	0	0
1941	9	3 Sep	11 Sep	794.3	5.35	3.21	19.1	8.1	27.2	793.2	792.2	790.4	790.1	80	50	0	0
1940	10	23 Jun	2 Jul	795.4	.35	.21	1.25	14.5	15.8	794.0	791.6	790.1	790.0	100	30	0	0
1939	10	26 Mar	4 Apr	795.1	.34	.24	1.43	13.1	14.6	793.8	790.1	790.0	790.0	95	0	0	0
1938	15	10 Sep	24 Sep	798.2	4.83	2.90	17.23	10.8	28.0	796.1	794.3	791.9	791.1	130	105	40	5
1936	10	25 Mar	3 Apr	794.4	.30	.21	1.25	11.4	12.6	793.4	790.0	790.0	790.0	85	0	0	0

Economic Evaluation

The economic evaluation consisted of determining pond level-frequency relationships for each selected pump rate, converting the pond levels to damages, determining average annual pumping station costs and average annual benefits and selecting the size of pumping station with maximum net benefits, based on current price levels and conditions. An average annual benefit-cost curve based on a gate closure at elevation 790.0 and pump on and off elevations of 789.5, 789.0, 790.0, and 789.5, respectively, are shown on Plate D-11.

The pond level frequency relationships based on a gate closure level of 790.0, the selected pumping rates, and the plan of operation are presented in Plate D-12. The curves were obtained by plotting the maximum pond levels obtained from Table D-9 against the appropriate Weibull plotting point based on the 45-year peiod of record (reference n.).

Damage-frequency curves for the selected pumping conditions are presented on Plate D-13 and are based on the pond level frequency relationships presented in Table D-10. Average annual damages are equal to the area under each curve. Average annual benefits shown in Table D-11 are based on the differences between average annual damages with and without pumping.

Estimated average annual costs for the selected pumping station capacities were obtained from the pumping cost-capacity curve presented on Plate D-25 of Design Memorandum No. 7 for Mankato, Minnesota (reference o.), corrected for the change in interest rates from 6 3/8 percent to 7 7/8 percent, and updated to price levels of October 1982. Average annual benefits and costs are based on an interest rate of 7 7/8 percent. The annual cost of pumps, motors and valves is based on a 35-year life. The cost of all other features is based on a 100-year life.

TABLE D-10

AREA A POND ELEVATIONS

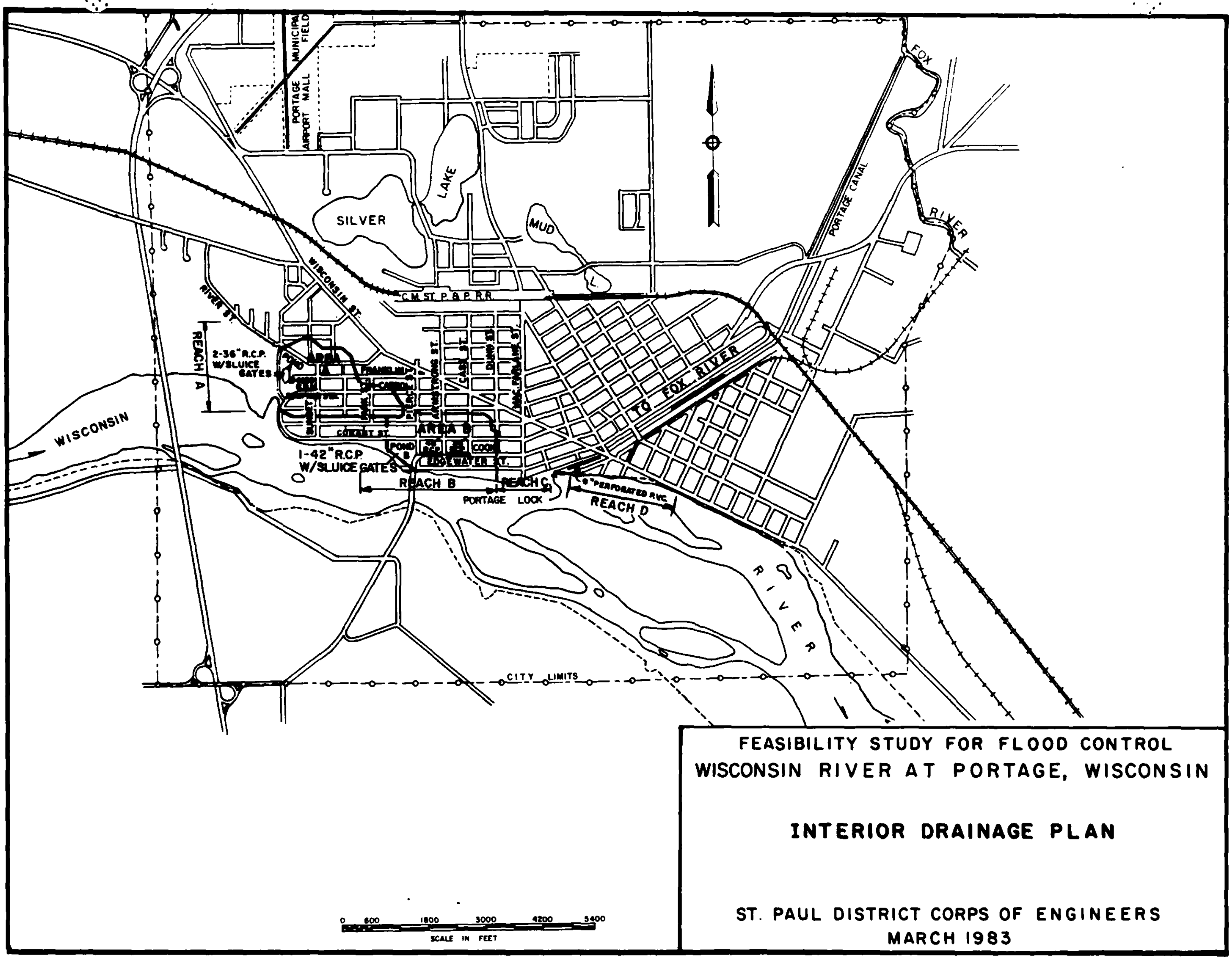
Elevation	Damages in Thousand Dollars	Exceedence Frequency in Percent Without Pumping	1,000 gpm	2,250 gpm	3,000 gpm
791.0	0	98	30	3.6	2.5
791.5	34	94	25	2.7	1.7
792.0	52	88	20	2.0	1.1
792.5	62	76	15	1.5	.75
793.0	72	60	11	1.1	.45
793.5	82	42	7.0	0.8	
794.0	92	27	4.2	0.6	
794.5	102	15	2.0		
795.0	110	12	0.7		
795.5	118	9.5	0.15		
796.0	127	3.0			
796.5	134	0.8			
797.0	140	0.15			

TABLE D-11

AREA A PUMPING STATION SIZE VS. AVERAGE ANNUAL BENEFITS

Pumping Station Size Nominal	Actual	Average Annual Cost @ 7 7/8 %	Average Annual Damages	Average Annual Benefits
0	0	-	$79,000	-
1,000	1,300	$21,400	$19,000	$60,000
2,250	3,000	$26,400	$ 2,100	$76,900
3,000	4,000	$30,500	$ 1,200	$77,800

The optimum size pumping station size for Area A corresponds to an average annual cost of $26,500 as shown on Plate D-11. From Plate D-14, the optimum size is 3,000 gpm (2,250 gpm nominal size). Since the peak seepage rate in Area A is 3,000 gpm with the design head, two 2,000-gpm pumps are recommended.

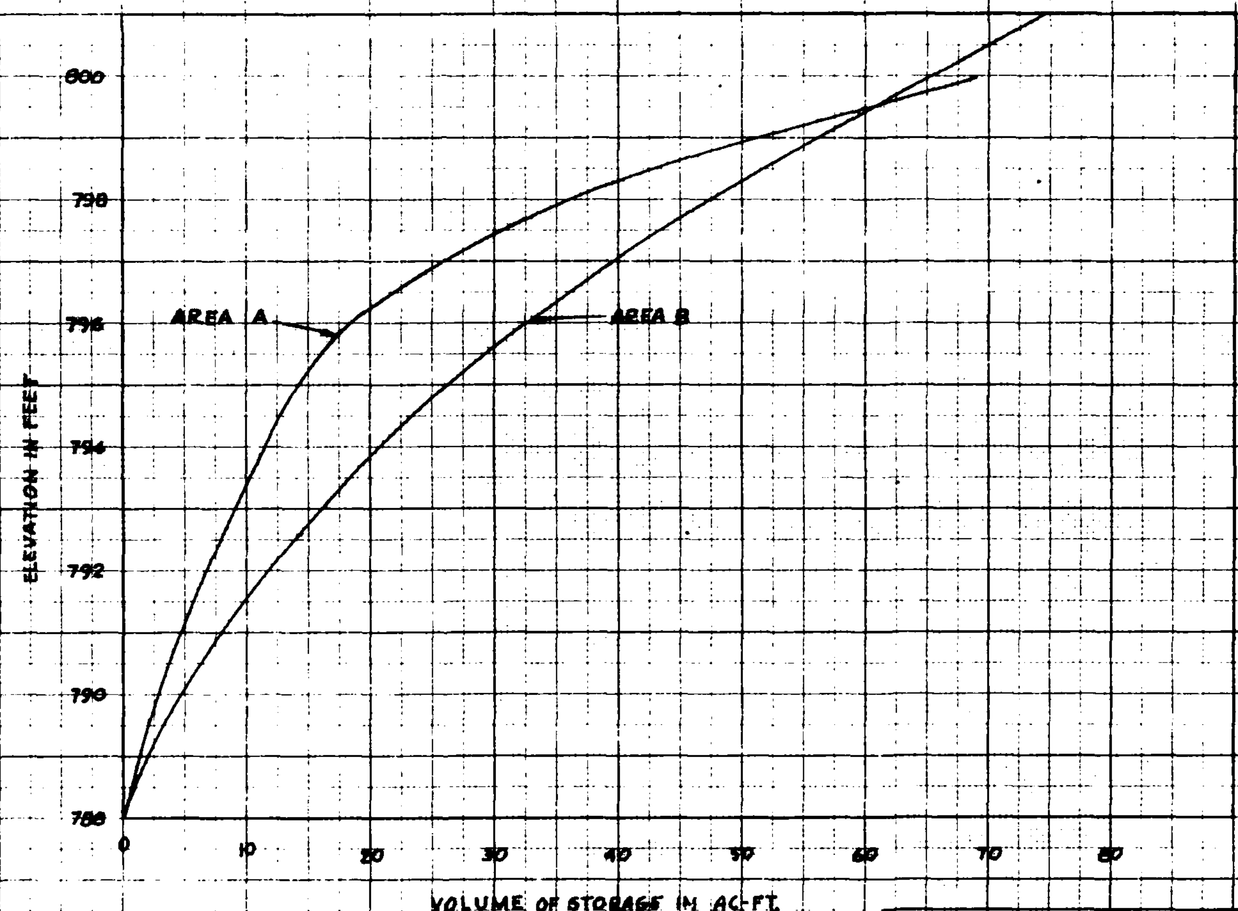


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN

INTERIOR DRAINAGE PLAN

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

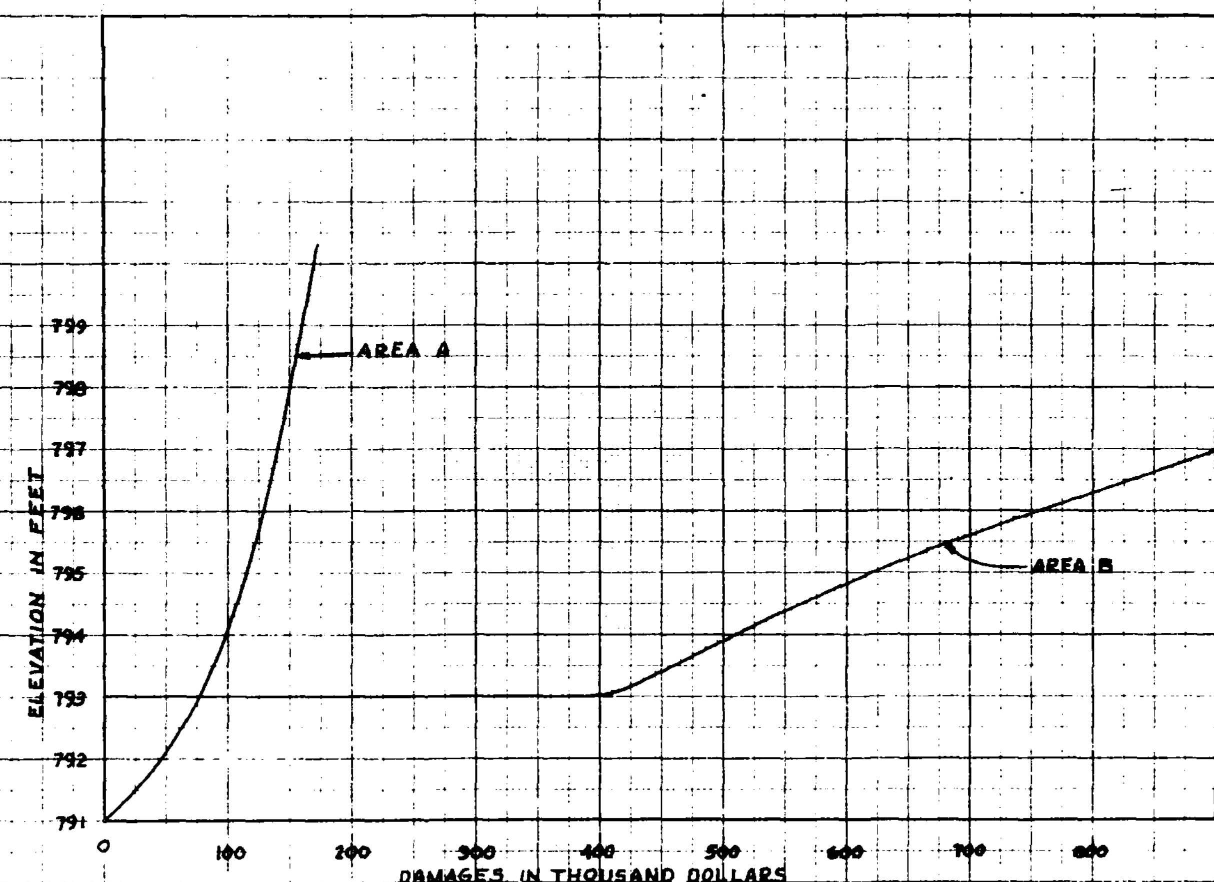
PLATE C-1



FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN

ELEVATION STORAGE CURVES
AREA A AND AREA B

ST PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

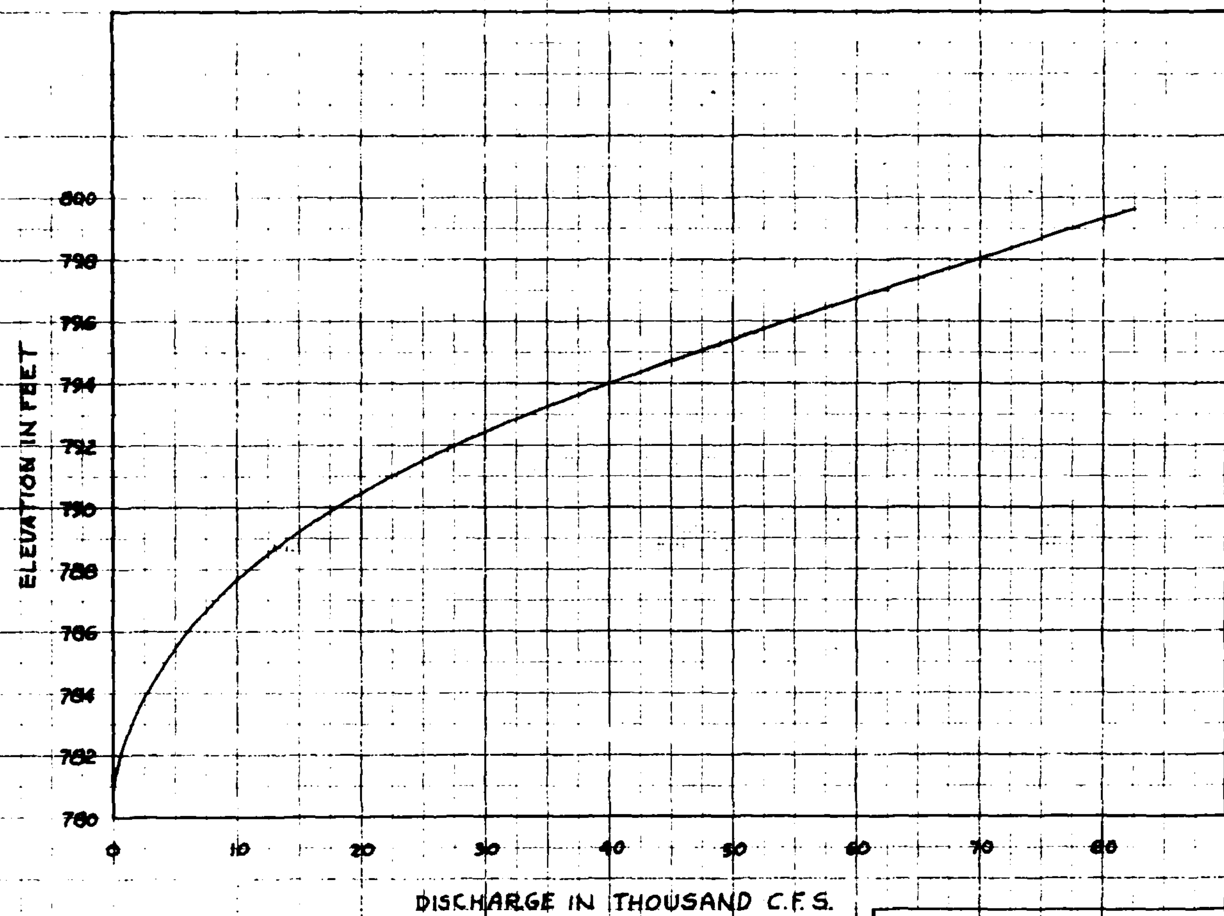


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE WISCONSIN

ELEVATION DAMAGE CURVES
AREA A AND AREA B

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-3

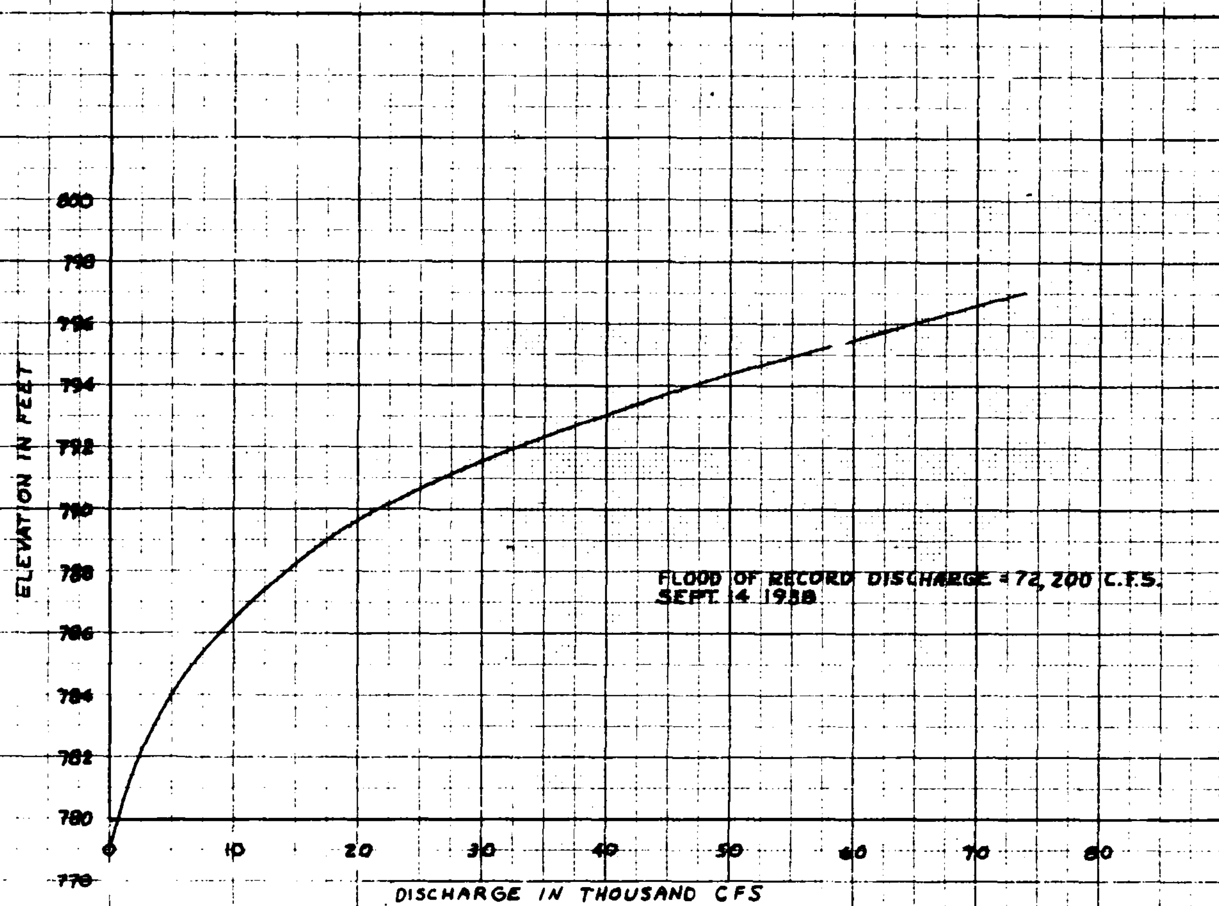


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE WISCONSIN

RATING CURVE AT
OUTLET A

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-4

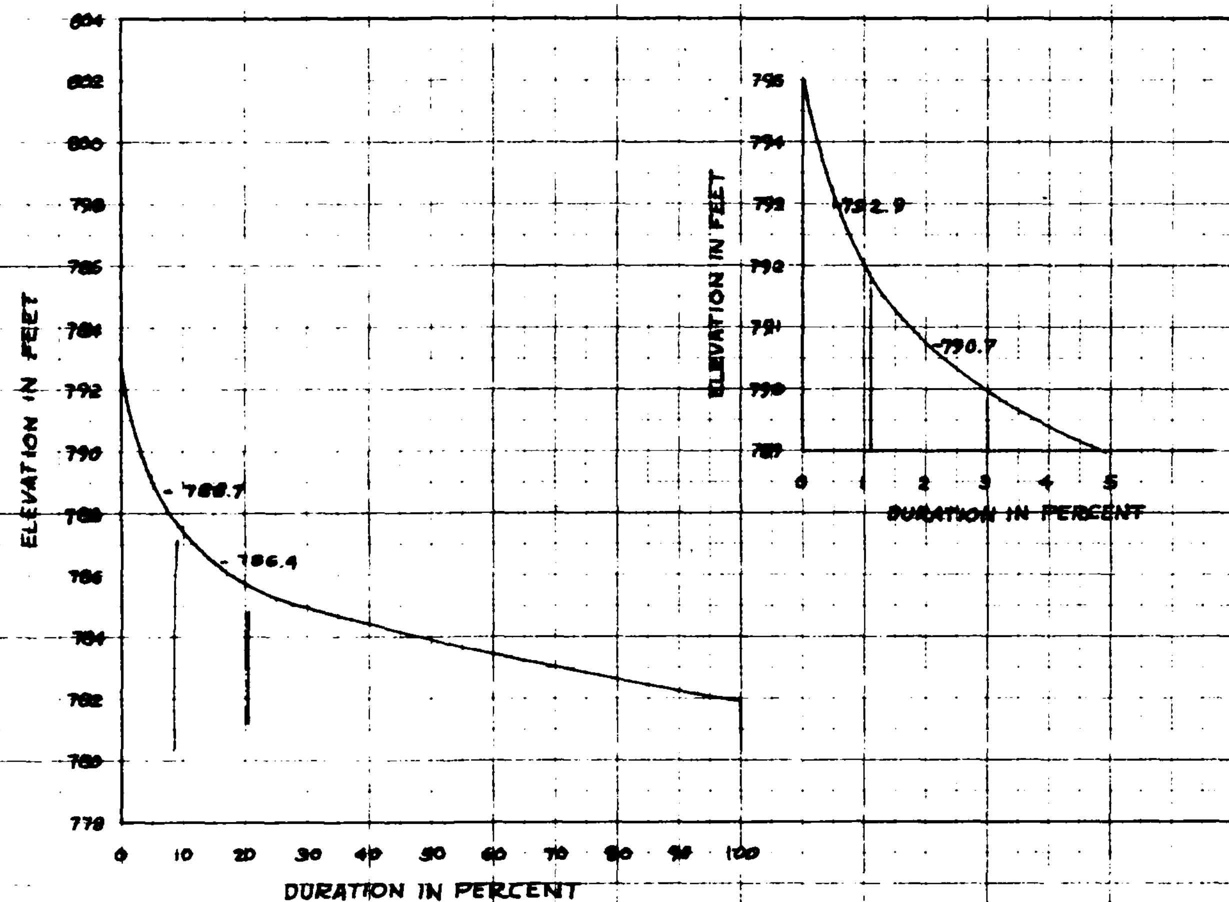


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN

RATING CURVES AT
OUTLET B

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-5

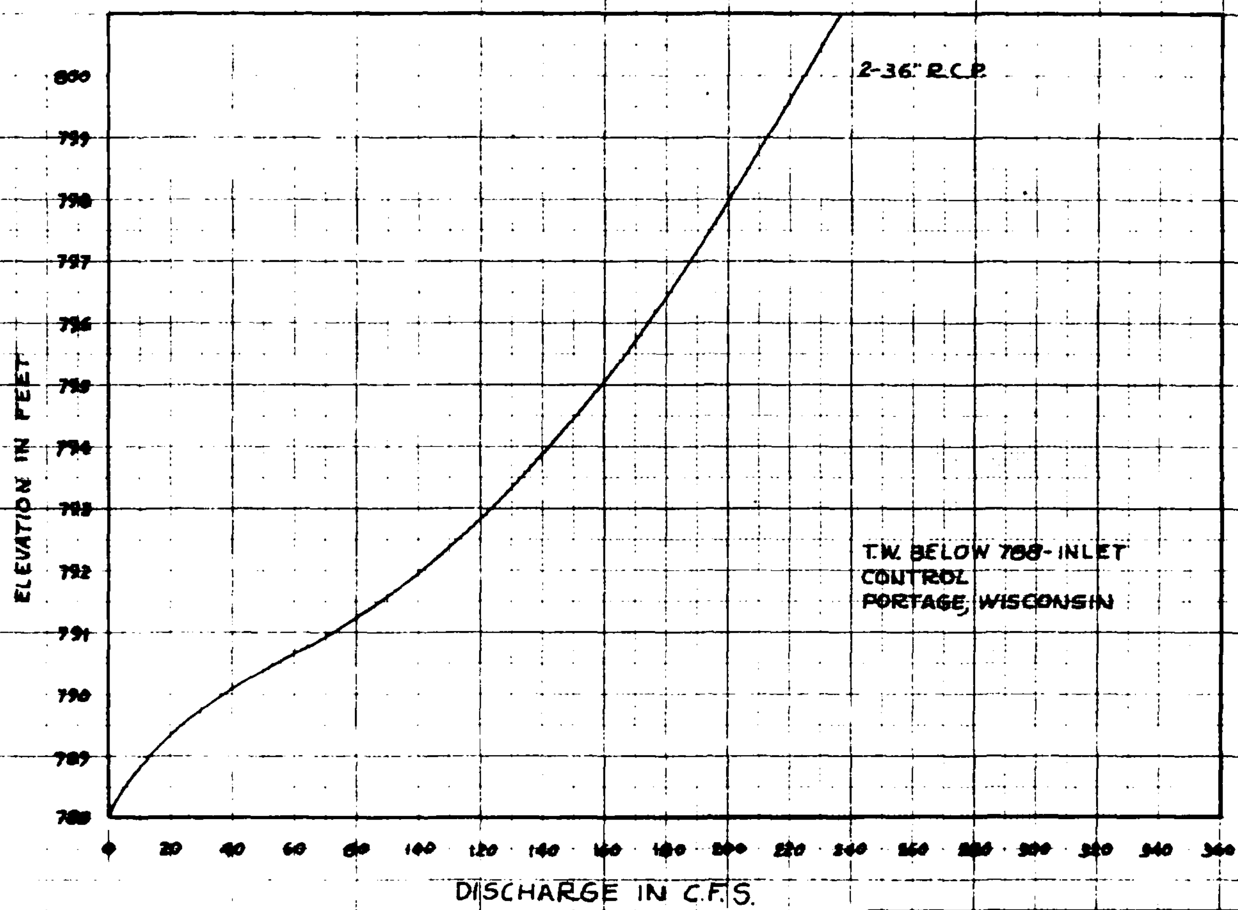


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE WISCONSIN

ELEVATION-DURATION
FOR OUTLET B

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-6

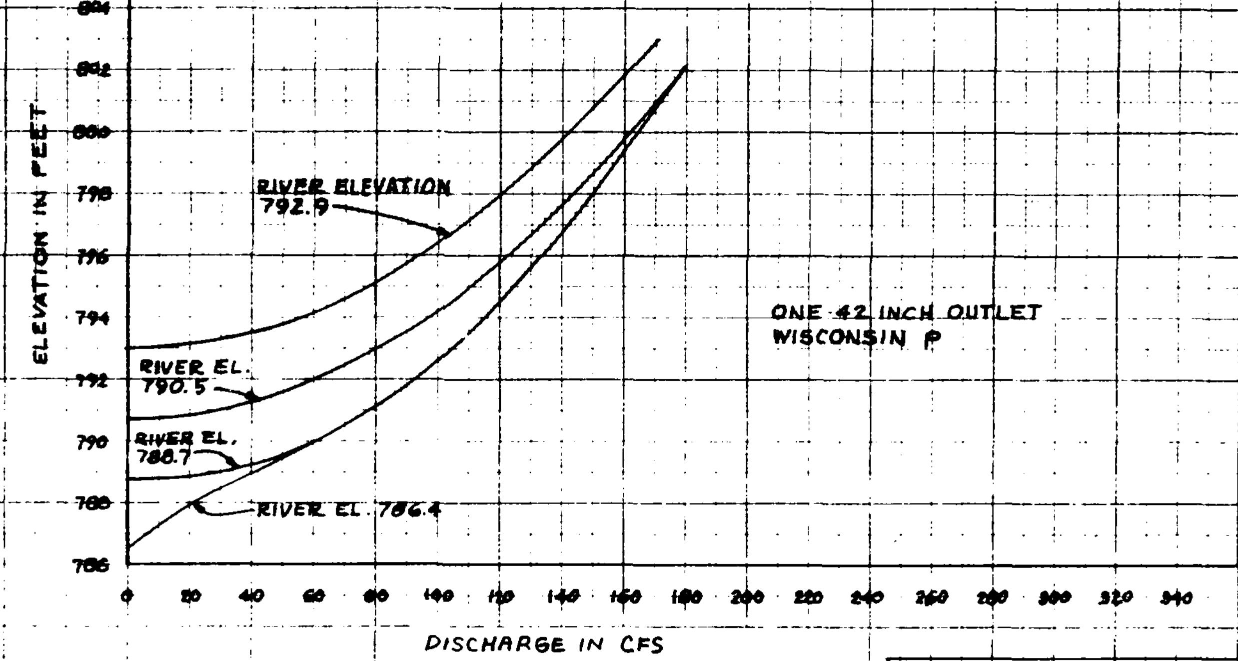


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN

ELEVATION - DISCHARGE
RATING CURVE FOR OUTLET A

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-7

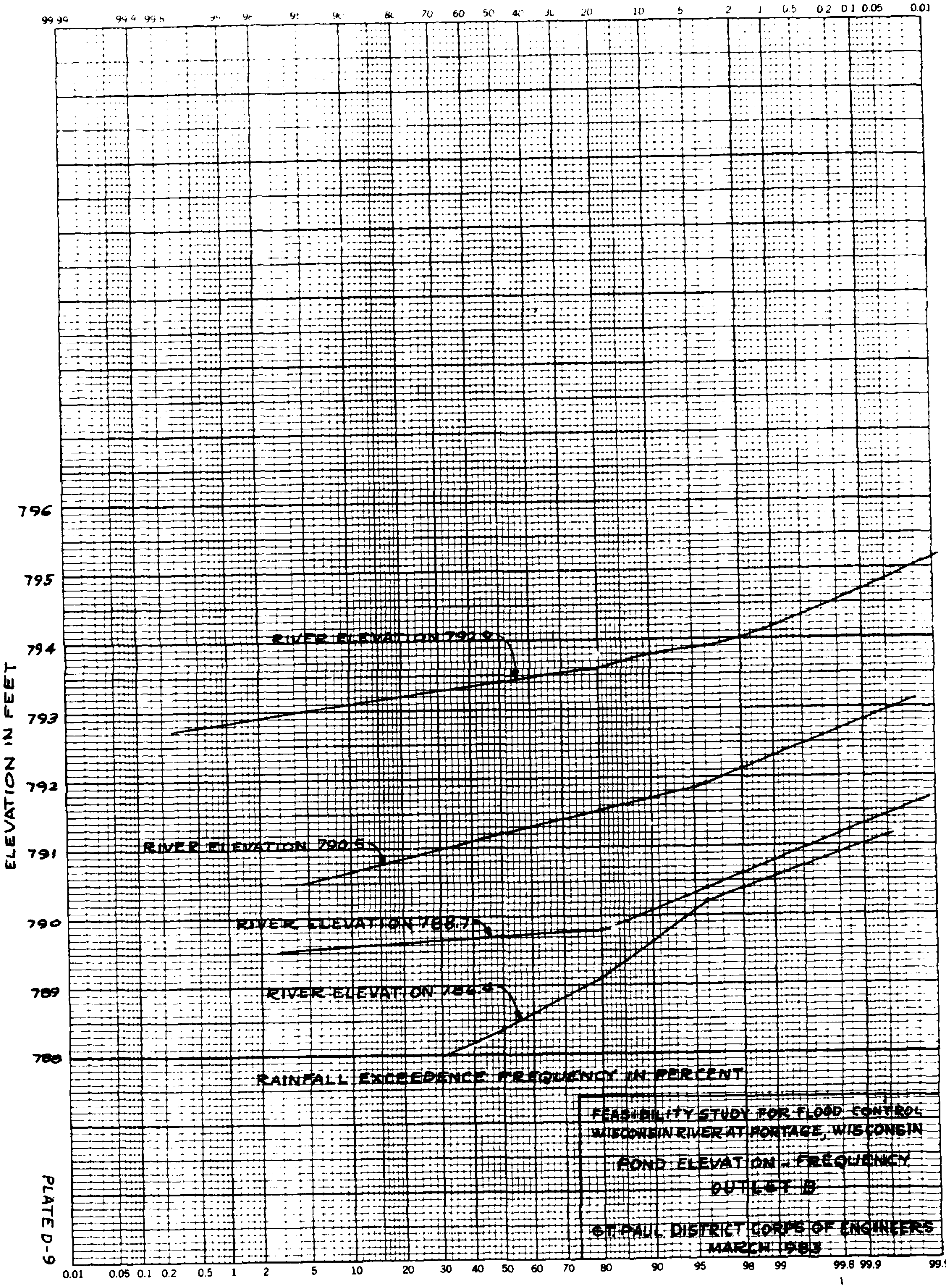


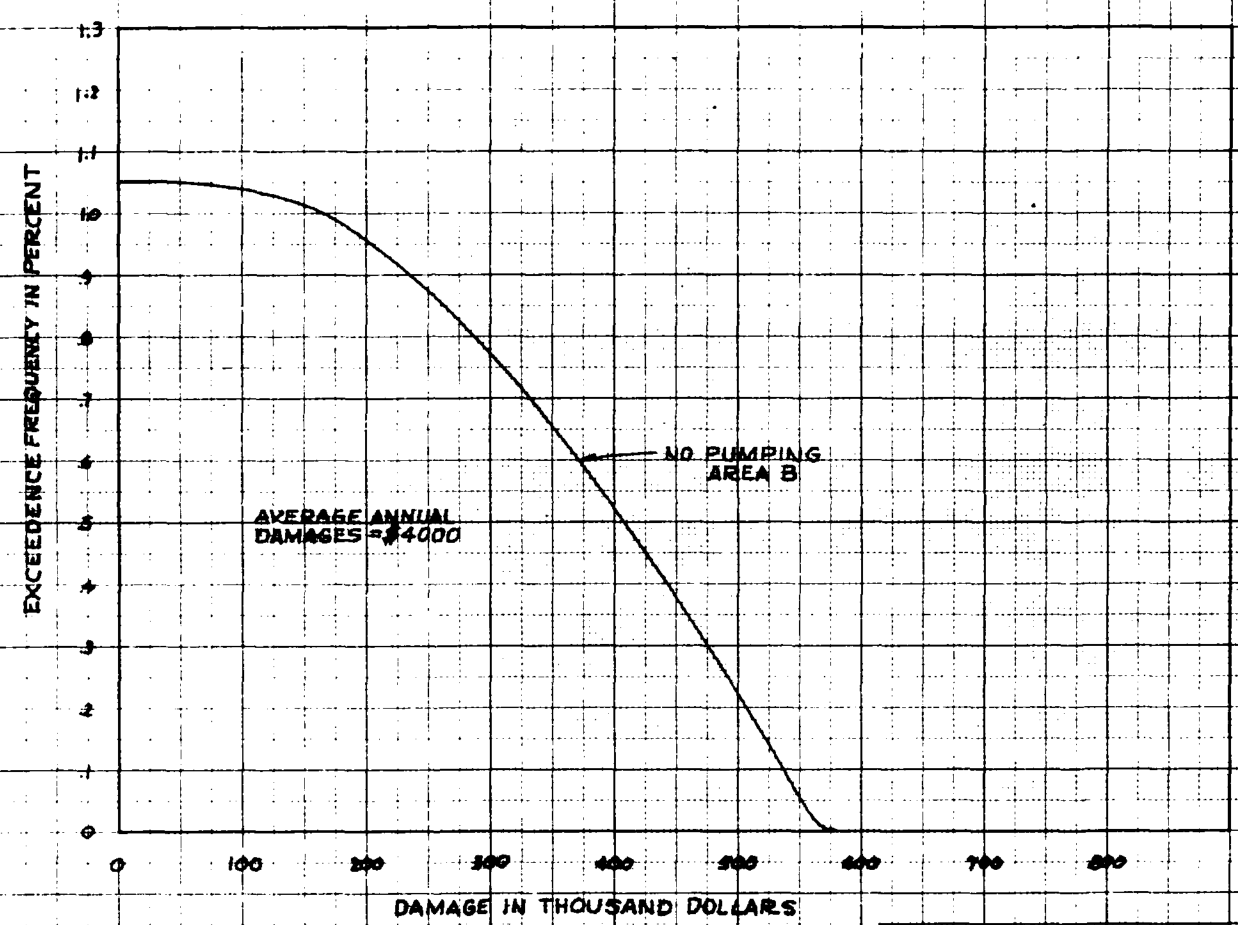
FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN

ELEVATION - DISCHARGE
RATING CURVE FOR OUTLET B

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-8


ELEVATION IN FEET
RAINFALL EXCEEDENCE FREQUENCY IN PERCENT
RIVER ELEVATION 792.9
RIVER ELEVATION 790.5
RIVER ELEVATION 788.7
RIVER ELEVATION 786.9
FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN
POND ELEVATION - FREQUENCY
OUTLET B
ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983
PLATE D-9

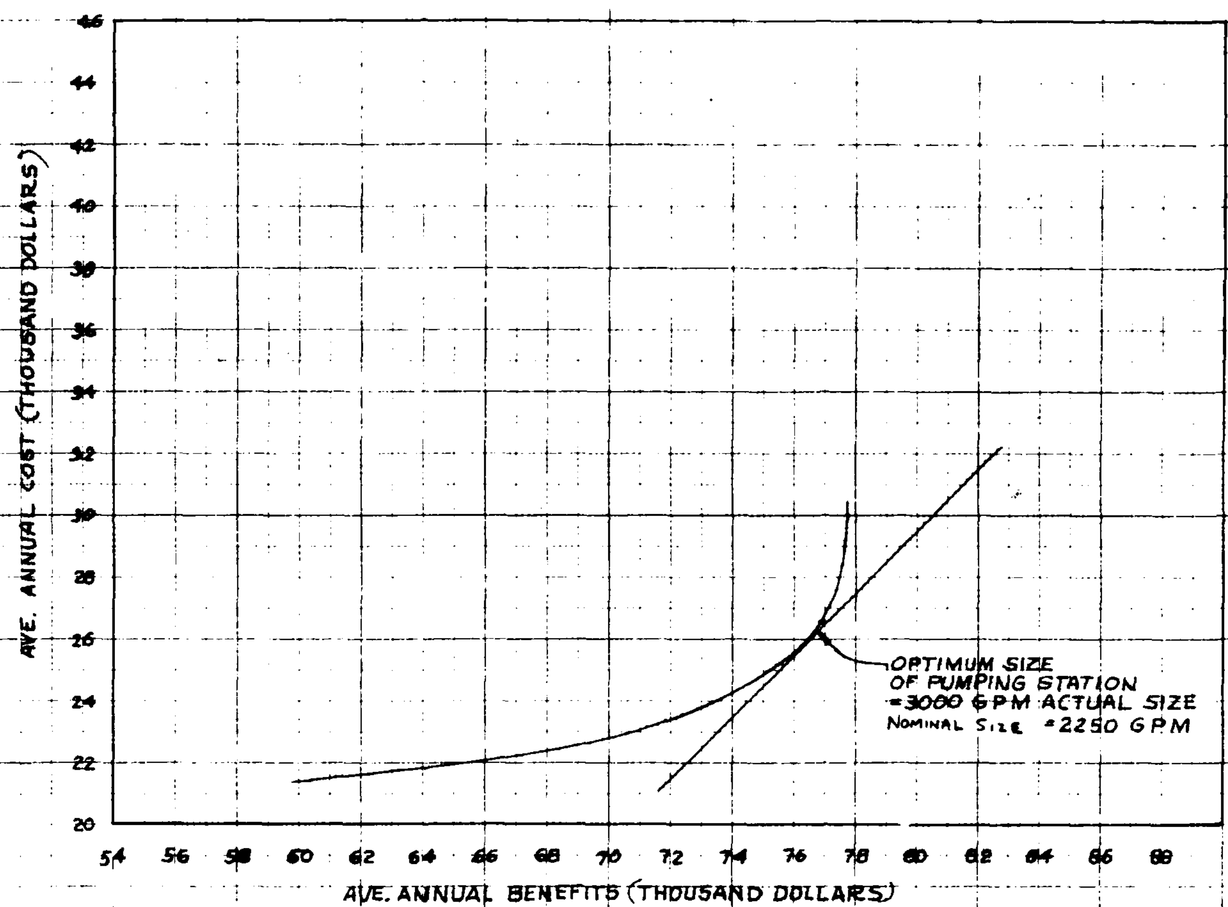


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE WISCONSIN

DAMAGE - FREQUENCY CURVE
AREA B

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-10

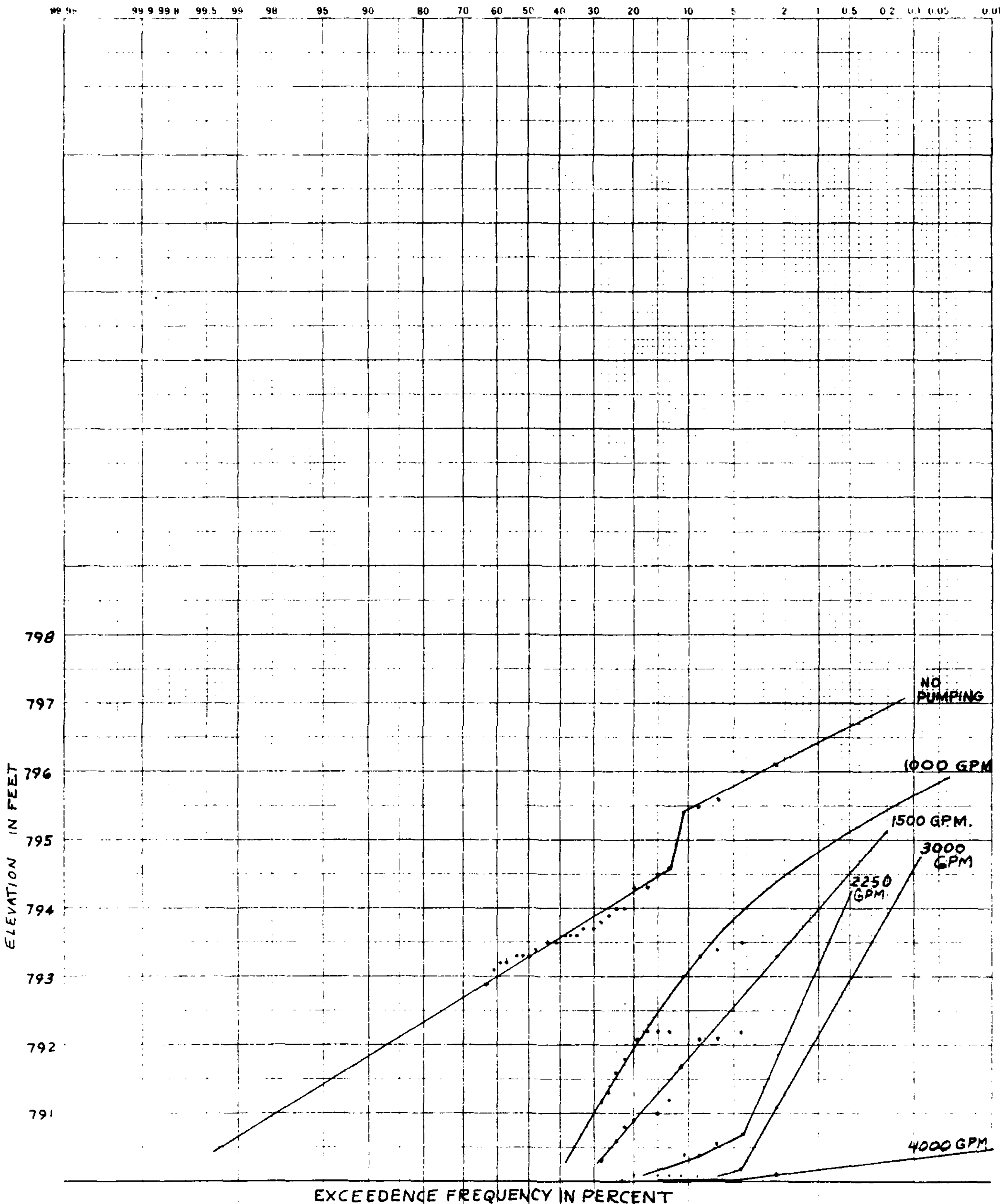


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE WISCONSIN

ECONOMIC EVALUATION FOR
AREA A PUMPING STATION

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-11

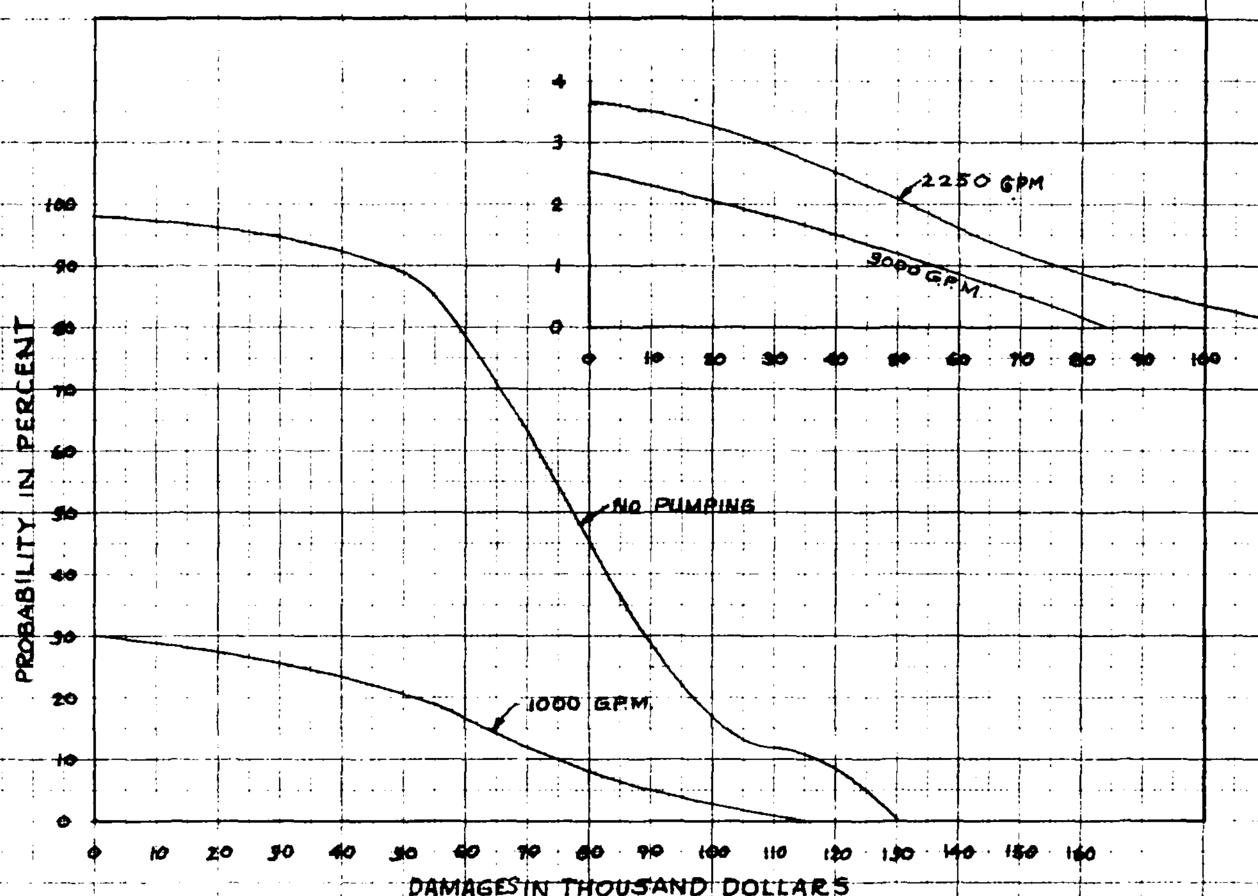


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE WISCONSIN

POND ELEVATION-FREQUENCY
AREA A

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-12

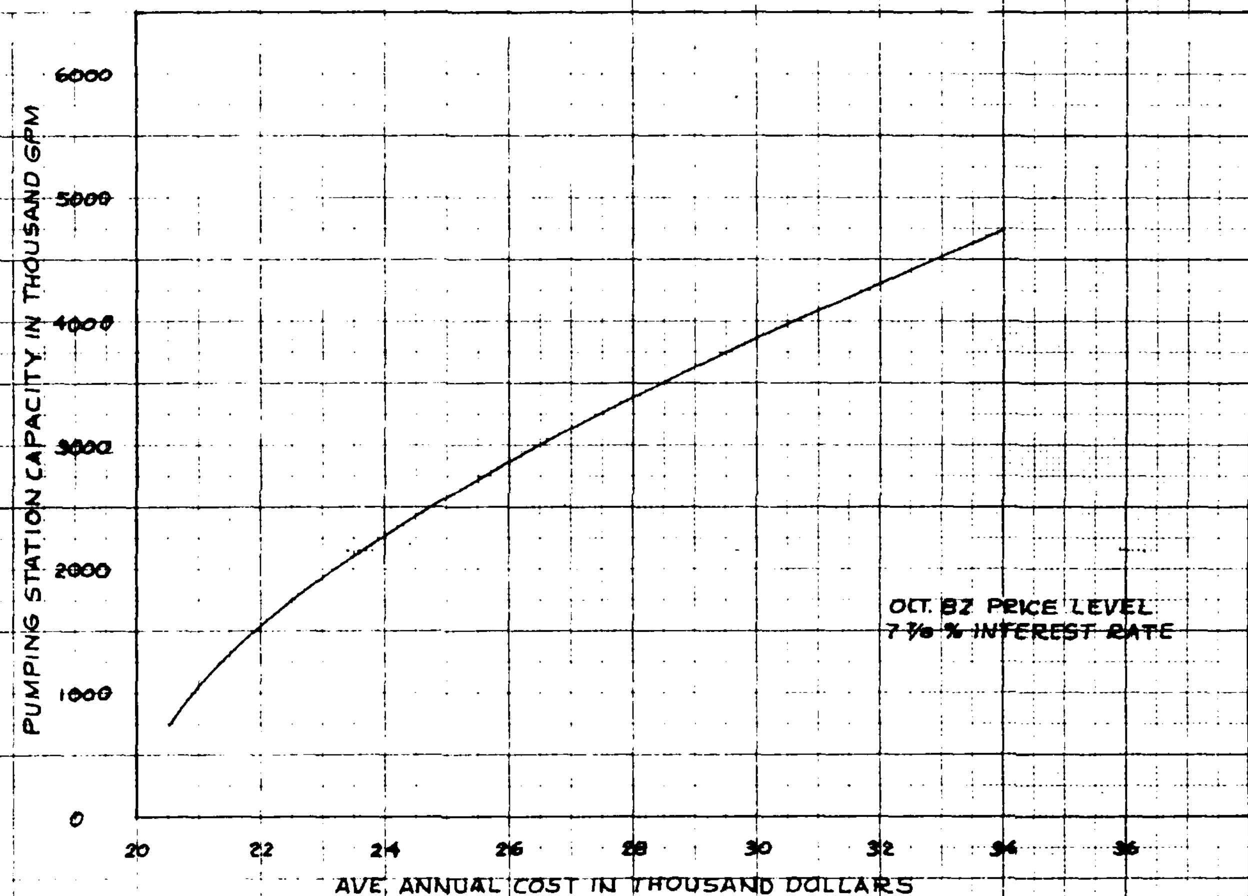


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE WISCONSIN

FRECUENCY DAMAGE
CURVE - AREA A

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-13



FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN

PUMPING STATION COST

ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

PLATE D-14

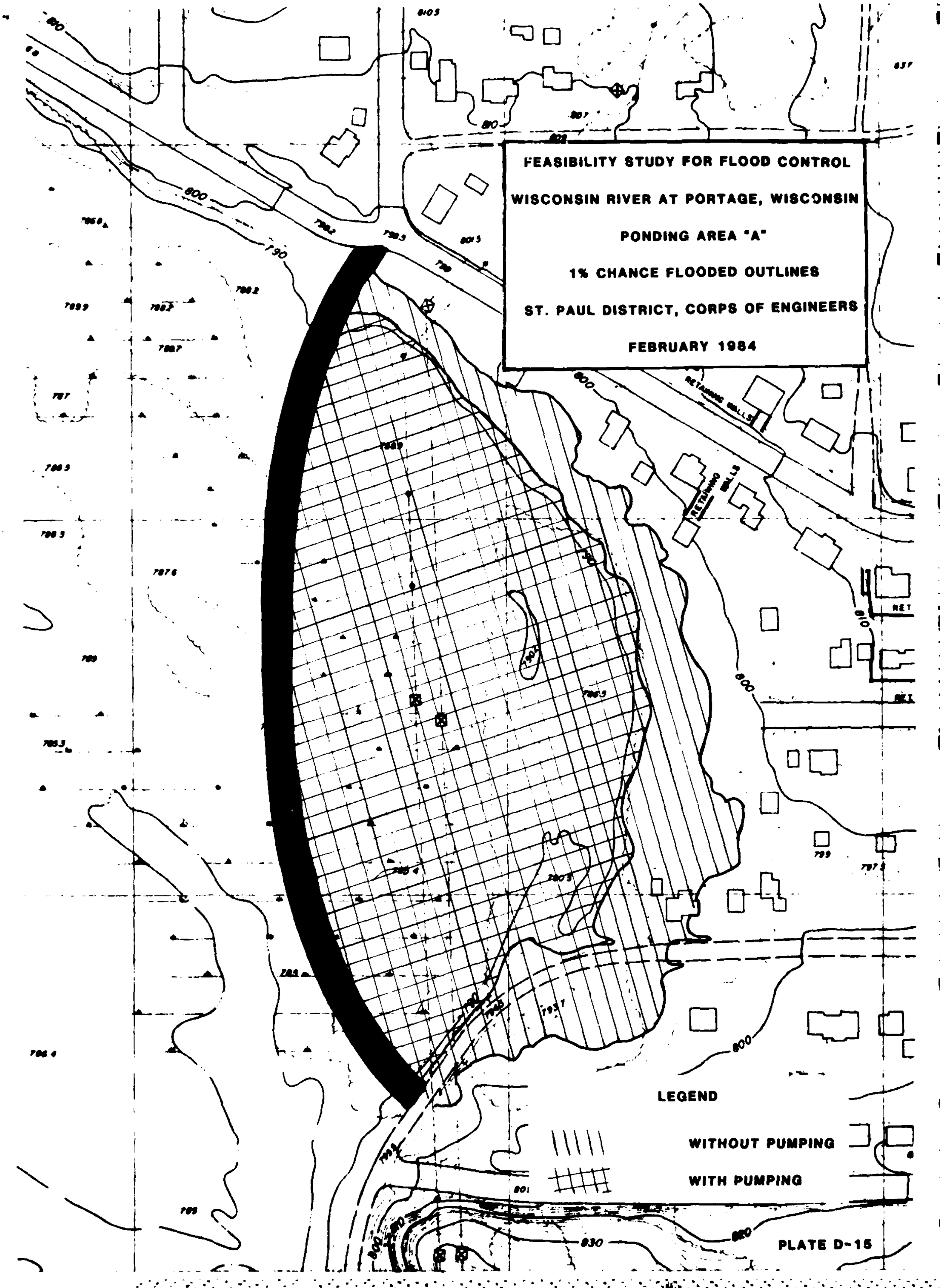
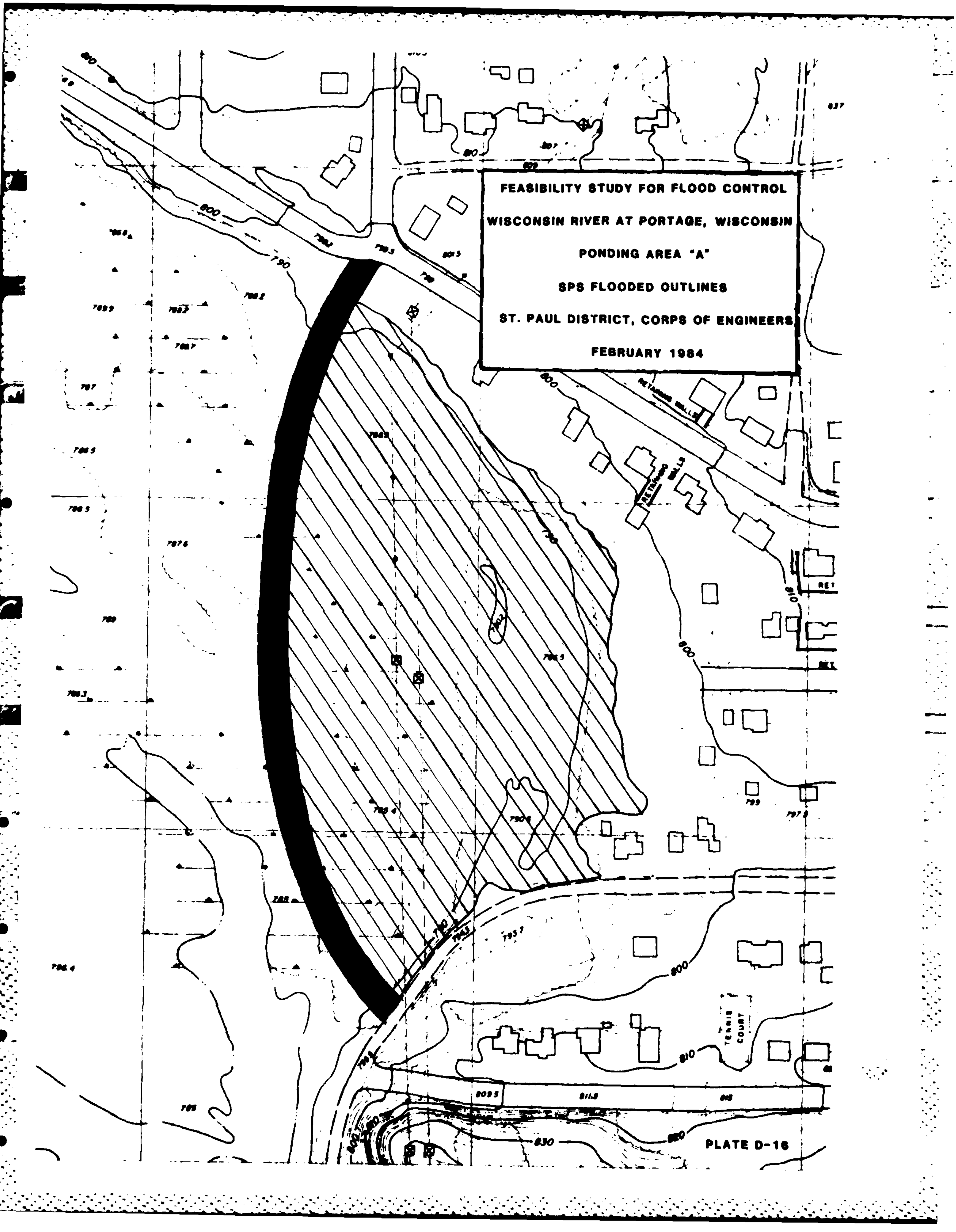

FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN
PONDING AREA "A"
1% CHANCE FLOODED OUTLINES
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FEBRUARY 1984
LEGEND
WITHOUT PUMPING
WITH PUMPING
RETAINING WALLS
800
790
810
830

PLATE D-15


FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN
PONDING AREA "A"
SPS FLOODED OUTLINES
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FEBRUARY 1984
RETAINING WALLS
TENNIS COURT
PLATE D-16

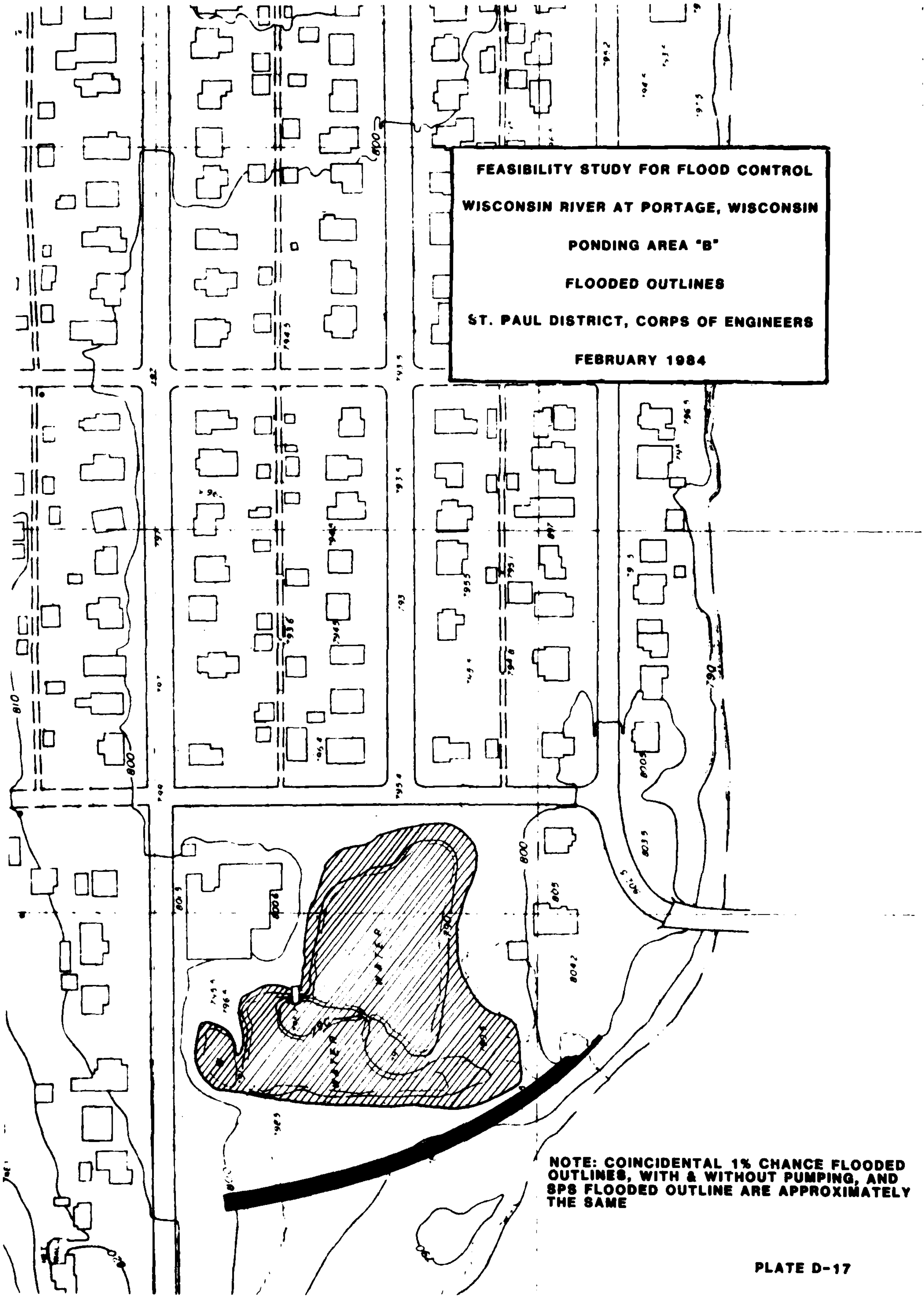

FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN
PONDING AREA "B"
FLOODED OUTLINES
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FEBRUARY 1984
800
810
790
WATER
NOTE: COINCIDENTAL 1% CHANCE FLOODED OUTLINES, WITH & WITHOUT PUMPING, AND SPS FLOODED OUTLINE ARE APPROXIMATELY THE SAME

PLATE D-17

FEASIBILITY STUDY FOR FLOOD CONTROL

WISCONSIN RIVER

at

PORTAGE, WISCONSIN

APPENDIX E

GEOTECHNICAL INVESTIGATIONS

December 1983

APPENDIX E

GEOTECHNICAL INVESTIGATIONS

TABLE OF CONTENTS

PLATES

PLATES

GEOTECHNICAL INVESTIGATIONS

GENERAL DESCRIPTION

The Wisconsin River flows eastward into Portage and curves southward within the city limits. An extensive floodplain of the Wisconsin River lies at an elevation of approximately 790 feet above mean sea level. This floodplain extends south of Portage for about 3 miles at which point the hills of the Baraboo Range rise abruptly above the plain to elevations over 1500.

To the north and east of Portage lie large swampy plains with general surface elevations of 790 to 800. These plains are interrupted by numerous hills which dominate the topography several miles north of Portage and rise to elevations over 1000.

Prior to settlement of the Portage area, flood waters from the Wisconsin flowed across the alluvial plains with part of the flow entering the adjacent Fox River Basin. As Portage developed, levees were constructed to protect the City from Wisconsin River flooding. Maintaining, raising and rebuilding of the levees have been a continuing process since the mid-nineteenth century.

GEOLOGIC SETTING

GLACIAL GEOLOGY

The Portage area was heavily glaciated during the Pleistocene Epoch. The most recent glaciation was during the Woodfordian Substage of the Wisconsin Stage with the ice retreating from the area approximately 12,500 years ago. The Green Bay Ice Lobe of the Wisconsin Stage advanced southward up the Fox River Valley and spread westward across the Portage vicinity. The glacier extended as far as Devils Lake in the Baraboo Complex eight miles southwest of Portage. When the glacial ice eventually melted, it deposited a thick blanket of glacial till and outwash soils which formed a kettle-moraine topography.

As the glacial ice front retreated northward, drainage water was impounded in the lowlands forming glacial Lake Wisconsin which inundated the area to an elevation of about 1000 and drained westward into the Black River 80 miles northwest of Portage. Sediments deposited in Glacial Lake Wisconsin and several earlier lakes filled low areas between the glacial hills and formed discontinuous marshy plains after the lake drained.

As Glacial Lake Wisconsin receded, the drainage courses of the Wisconsin and Fox Rivers were established in approximately their present locations.

The glacially deposited soils in the Portage area consist primarily of till and range in thickness from 0 to 300 feet. However, washed sand and gravel deposits of outwash material, as well as lacustrine sediments, exist within and over the till. The glacial deposits generally occur near the surface on the hills which rise above the plains in the area.

The alluvial soils which form the plains consist of lacustrine silt, clay and fluvial sand and gravel. The alluvial soils are extensively overlain by swamp deposits of peat and muck.

BEDROCK GEOLOGY

Bedrock under the Portage area consists of Cambrian sandstone strata of the Galesville, Eau Claire, and Mt. Simon formations. The formations are sedimentary marine deposits composed primarily of medium to very fine quartz sand. The sandstones contain some shale layers.

Precambrian crystalline bedrock underlies the sandstone strata. A contour map of the bedrock surface, taken from the Environmental Impact Statement for the Portage Wastewater Treatment Facility, is shown on Plate E-13 of this report.

GROUND WATER

Ground water flow in the Portage vicinity moves toward and discharges

into the Fox River, the Wisconsin River, the Baraboo River (a tributary of the Wisconsin River) and into Big Slough Creek which eventually enters the Fox River. The ground-water divide between Mississippi River drainage and Lake Michigan drainage passes diagonally under the City of Portage and approximately underlies the surface water divide.

Alluvial deposits of sand and gravel, glacial outwash deposits of sand and gravel, and sandstone bedrock form the major aquifers utilized for water supply. High capacity wells have been successfully developed in all three of these types of aquifers in the Portage area.

REGIONAL DRAINAGE

The Portage area is poorly drained and characterized by extensive marshy areas. The poor drainage development is due to the relatively recent glaciation and low relief of the area.

The City of Portage is situated on the hydrologic divide between the Wisconsin River drainage basin and the Fox River drainage basin. The Wisconsin River flows southeast through the City and empties into the Mississippi River. The Fox River flows northwest along the northeast corner of the City of Portage and empties into Lake Michigan.

The two rivers are separated by less than 3000 feet of marshy floodplain. As a result of this unique situation, portions of the City lie on a floodplain common to both rivers. Surface drainage of the Portage area flows directly into both rivers through small intermittent streams, sloughs, and marshes.

SUBSURFACE INVESTIGATIONS AND SOIL DATA

The subsurface investigation consists of 13 machine borings taken by the Corps of Engineers in 1982 and 5 borings taken in 1979, under the direction of the Architect-Engineering firm preparing the Stage 2 report. The boring locations are shown on Plate E-1 and the detailed logs are presented on Plates E-2 through E-8. Detailed laboratory

test data and gradation curves are shown on Plates E-9 through E-12.

The soils in the project area consist primarily of clean to slightly silty sands mantled by silty sands, silts and clays. Borings 82-9M, 82-10M and 82-11M show or indicate the presence of significant clay layers in the pervious aquifer and are examples of how these variations may be encountered. At this time, it is assumed that these clay layers are not continuous, but future investigations should identify the extent and locations of the deposits so a better determination can be made as to their impact on the project.

PROJECT FEATURES

In general, all proposed levees will be pervious with methods of reducing uplift or possible exit gradient problems employed in three areas as follows: 1) a seepage berm will be utilized from Ontario Street to the downstream end of the project. See Section 1 on Plate E-14; 2) a small perforated pipe will be placed parallel to the Portage Canal downstream from the end of the lock to where the canal and the river tend to diverge, approximately 1100 feet, to intercept any seepage that might exit on the banks which could cause sloughing in the historic canal. See Section 3 on Plate E-14; and 3) sheetpile will be placed as necessary to increase the creep path beneath the floodwall for the alternative in which the lock structure is to be used as part of the flood barrier. The levee configuration will have 1V on 3H riverward slopes, 1V on 5H landward slopes and a minimum 10-foot top width. The levee top width will be increased for the levee-road raise in Ward 8 to accommodate an existing road in this area. In the area just upstream from the lock, the riverward slope will be steepened to 1V on 2½H to limit encroachment into the canal area.

DESIGN ANALYSIS

SEEPAGE AND UPLIFT

Quantities of seepage were computed for determining interior drainage

requirements for: 1) the levee in Ward 8; 2) the levee in Pauquette Park (just upstream from the Highway 33 / 78 bridge) and the 1400-foot reach downstream from the bridge to where the levee ties into higher ground; and 3) from the upstream end of the lock to Ontario Street where the levee will follow the Highway 16 / 51 alignment. Seepage quantities downstream of Ontario Street were not computed because they were not critical to interior drainage design. Review of the boring logs indicated that uplift could be a problem for the levee downstream of Ontario Street. Analysis indicated that a berm of dimensions shown on Section 1 of Plate E-14 is required.

Seepage quantities were estimated by drawing preliminary flow nets except for the area from the Portage lock to about 1100 feet downstream where the Portage Canal and the Wisconsin River diverge. In this area, it was felt that an accurate flow net would be difficult to construct due to the influence of the Portage Canal. Computations, therefore, assumed a theoretical impervious boundary placed at elevation 770. Seepage above the boundary was calculated by the Method of Fragments presented in the text, *Mechanics of Particulate Media,* by M. E. Harr, and seepage below the boundary was computed assuming Darcy's Law. These quantities are estimates and may later require finite element analysis. It was assumed that impervious seams or layers are not continuous and that the foundation and levee would be of homogeneous material. The horizontal permeabilities used in the analyses were determined from D_{10} grain sizes and the results of field pumping tests as summarized on Figure 17, Page 51, TM 3-424. In areas where D_{10} sizes were not available the grain sizes were assumed, based on gradation tests of material in other areas of the project. A summary of the seepage quantities is presented below based on the 500-year design water surface.

Levee Location	Estimated Seepage (gpm)
Ward 8	5000
Upstream of Highway 33/ 78 Bridge	1050
Highway 35 / 78 Bridge to 1400 feet downstream	350
Portage lock to 1100 ft. downstream	2530
1100 ft. downstream of Portage lock to Ontario Street	6660

Uplift pressures downstream of Ontario Street were analyzed using hydrostatic pressures caused by a water surface at the top of the flood barrier. Due to the lack of adequate subsurface information, the most critical boring for uplift, 82-8M, was used throughout the analysis for this area. It was assumed that the material not recovered in the first 3 feet of the boring was a continuation of the sandy clay soil seen just below the unrecovered sample. The analysis for seepage uplift was based on TM 3-424, Vol. I, *Investigation of Underseepage and Its Control - Lower Mississippi Levee*, by Waterways Experiment Station, Vicksburg, Mississippi, October 1956. Extensive subsurface investigation and testing would be accomplished during post-authorization studies to assure that an effective seepage control system is provided and that more accurate seepage estimates are computed. Placing an impervious zone on the riverward slopes of the levees will be considered to reduce seepage and increase stability.

SLOPE STABILITY

Slope stability analyses were not performed for this report other than checking the design levee slopes by the infinite slope formula. The levees will be constructed of pervious fill because of its availability. Using an anticipated conservative angle of internal friction of 30°, the factors of safety against surface sloughing either closely met or exceeded the required factor of safety of 1.4.

The possibility exists that deep seated failures could occur, such as at boring 82-10M where layers of organic material are present. However, the existing emergency levee, which is nearly equal in height to the proposed levee, shows no indication of slope stability problems. Adequate slope stability would be verified in post-authorization studies in which undisturbed sampling and strength tests would be available to determine the supportive capability of the foundation material in this reach. Partial removal, use of berms, or combinations of these measures are alternatives available to increase slope stability if required.

SETTLEMENT

The settlement will be analyzed during post-authorization studies when

additional subsurface data are available. The subsurface data available at this time and the anticipated loading conditions do not indicate any significant settlement problems.

BEARING CAPACITY

Bearing capacity is not expected to be a major problem because of the granular foundation expected in structural areas; however, standard penetration tests indicate that the foundation sands generally vary from a loose to dense relative density. Therefore, bearing capacity will be investigated in post-authorization studies when structural configurations, design loads and specific subsurface information are determined.

SLOPE PROTECTION

The slopes of ditches, landward levee slopes, seepage berms, some riverward levee slopes and tops of levees, except in Ward 8 where the levee road raise is proposed, would be covered with 4 inches of topsoil and seeded. Riprap and bedding protection would be provided at outfalls and on riverward levee slopes, where erosion would occur, as determined by Hydraulics. Typical levee and riprap sections are shown on Plate E-14.

EXISTING LEVEES

In general, the existing levees are narrow, steep-sloped, and sandy. Top width of the embankments is generally 6 to 8 feet with some exceptions of widths up to 17 feet. Side slopes range from approximately 1V on 1H to 1V on 3.5H on the river side of the levees and from about 1V on 1½H to 1V on 6H on the land side. The levees are vegetated on the slopes and top except for the Portage levee upstream of Ontario Street which is faced with riprap or a thin grouted riprap layer. The borings indicate the existing levees are built primarily of moderately silty sand and are underlain by loose to dense clean alluvial sands with discontinuous silty sand, silt and clay layers.

Although the levees have not been breached or overtopped since 1938, they are not considered reliable (to the top of levee elevation). The levee system has been built and upgraded haphazardly over a 100-year period, thus causing inconsistency in design and performance. The existing levees are susceptible to failure from piping and/or sloughing on the landward slope. Where the Portage levee is adjacent to Highway 16/51 through town, the top width averages about 16 feet, the river side slopes vary from 1V on 2½H to 1V on 3½H, which appear adequate, and the land side slopes range from 1V on 2H to 1V on 2½H. Past experience with sand levees has shown that land side slopes should be no steeper than 1V on 5H when utilizing 10-foot top widths and 1V on 3H riverward slopes, to eliminate surface sloughing associated with seepage exiting on the slope. The predominance of readily erodible material in both the levees and foundation creates a high potential for erosion. Sand boils have reportedly been noted by local interests during floods, and soft spots, especially downstream of Ontario Street, have been reported during times of relatively low heads. Remedial action to date has generally been to place additional sand fill on the boil areas and flatten the levee back slopes in areas where the levees have been repaired.

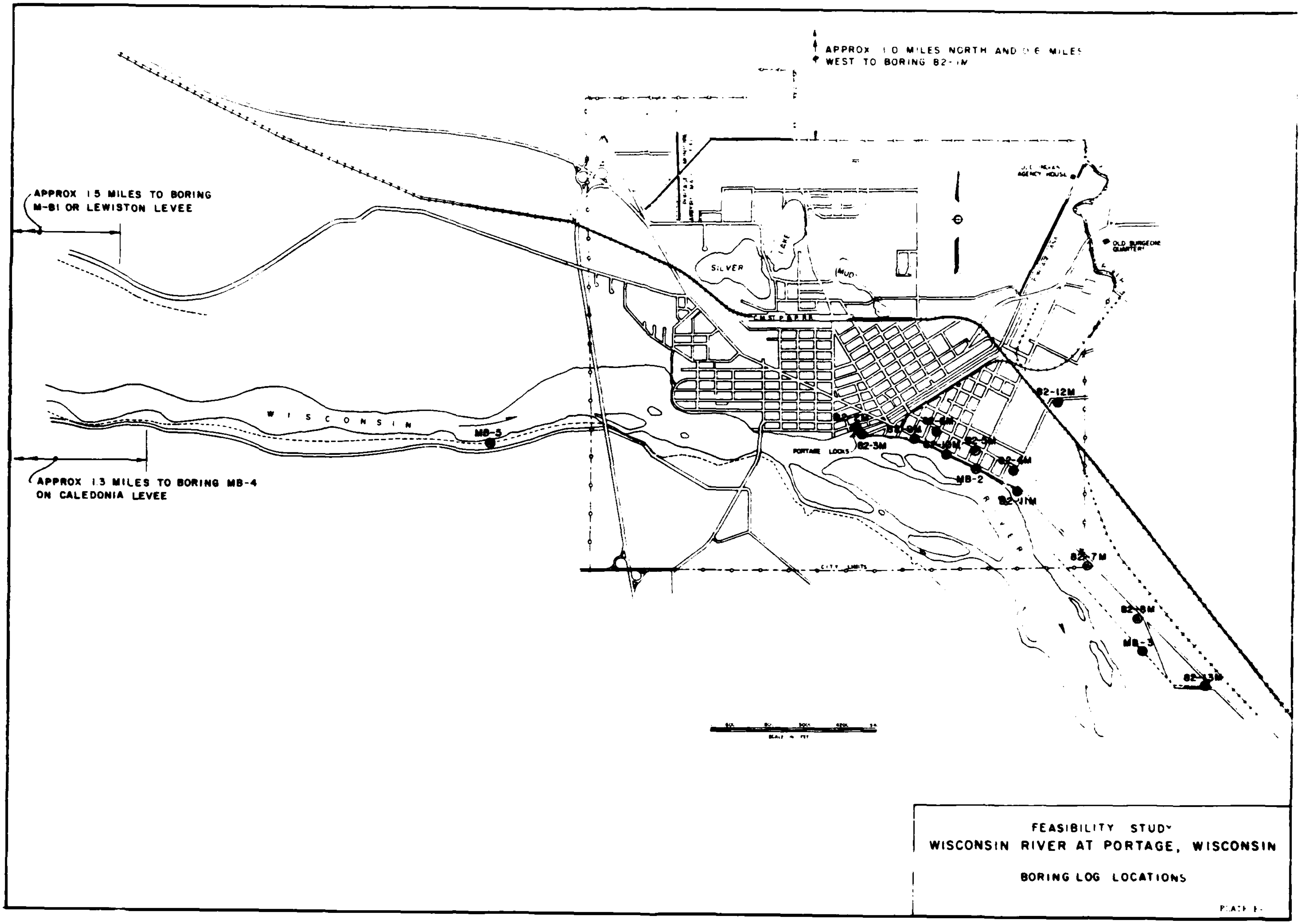
Maintenance of the levees includes removal of trees and woody vegetation and repair of rodent burrows, seep holes and erosion on an annual basis. The emergency preparedness plan includes patrolling of the levees and warning and evacuation of residents threatened by overtopping or failure of the levees. Because of regulation of the Wisconsin River by upstream dams, crest stage and time have been accurately predicted far enough in advance to permit orderly evacuation if considered necessary. Frequency of patrolling is determined by river stage, with continuous patrols specified for high stages. Additional discussion on the existing levees is presented in the main report.

CONSTRUCTION MATERIALS

Impervious material is not proposed for project use at this time. Therefore, sources of impervious material have not been identified. Rock

suitable for riprap is not available near the levees. Estimated minimum haul distance would be approximately 30 miles.

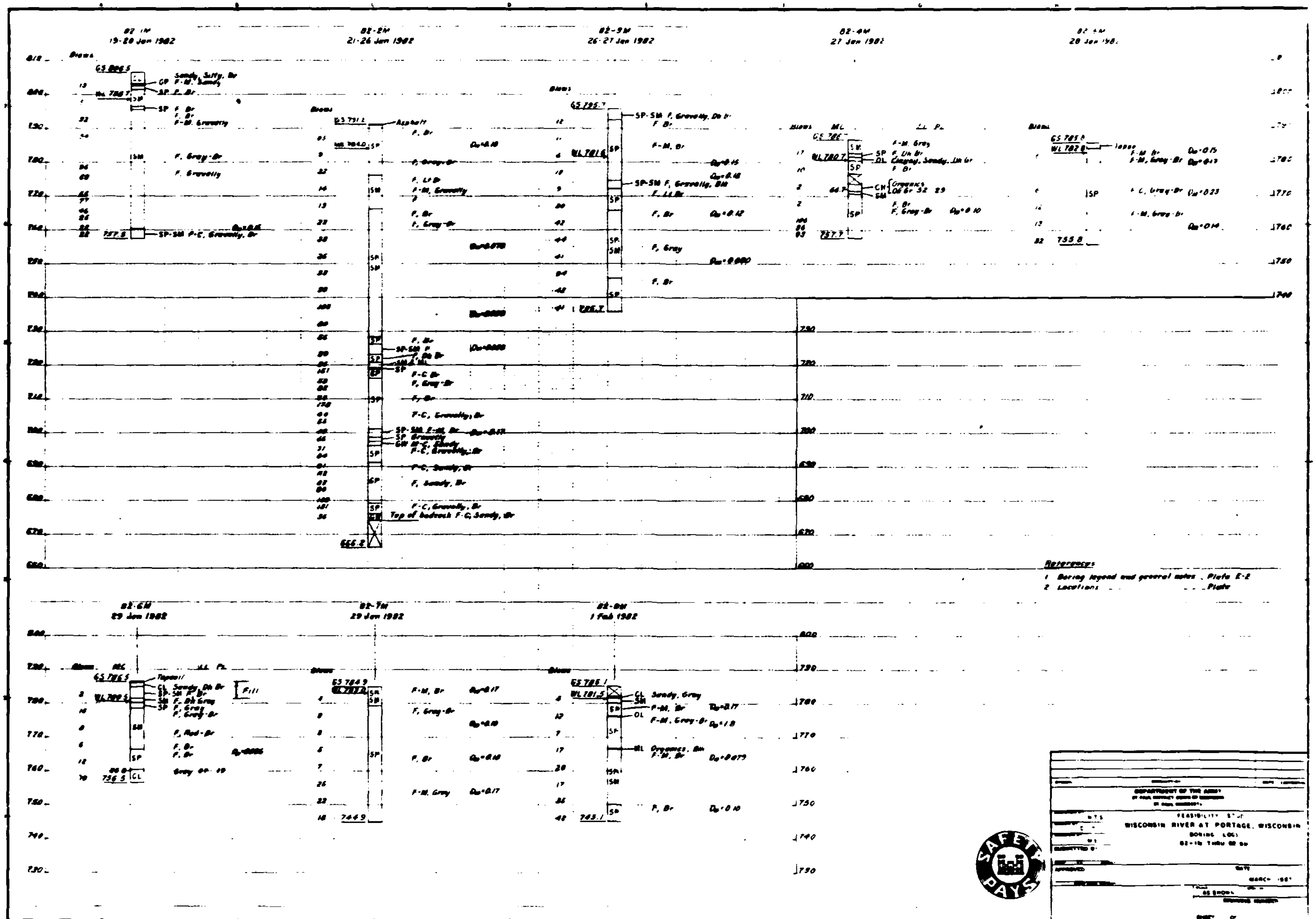
Sources of pervious material are available within the Portage project area. One possible source of borrow is excavation of river sand. The river channel is currently on the Caledonia side of the river. Pervious material could be excavated near the main channel with backhoes or clam shells and hauled across the sand deposit for stockpiling or direct placement into the project. Other sources would be sand pits in the vicinity of Portage. All sources of construction materials would be inspected and tested as required to insure adequate levee performance.



FEASIBILITY STUDY
WISCONSIN RIVER AT PORTAGE, WISCONSIN

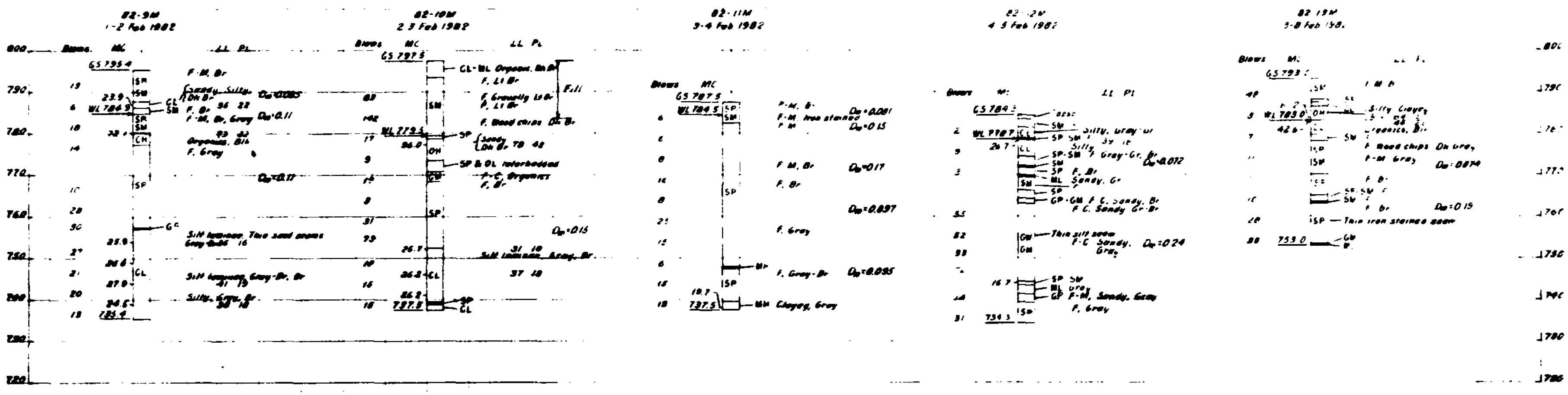
BORING LOG LOCATIONS

PLATE



82-1M
19-20 Jan 1982
82-2M
21-26 Jan 1982
82-3M
26-27 Jan 1982
82-4M
27 Jan 1982
82-6M
29 Jan 1982
82-7M
29 Jan 1982
82-8M
1 Feb 1982
Top of bedrock F-C, Sandy, Br
References
1 Boring layout and general notes . Plate E-2
2 Locations . . . Plate
DEPARTMENT OF THE ARMY
FEASIBILITY STUDY
WISCONSIN RIVER AT PORTAGE, WISCONSIN
BORING LOGS
AS SHOWN

PLATE E-



BORING LEGEND

GW	Well graded gravels, little or no fines
GP	Poorly graded gravels, little or no fines
GM	Silty gravels
SP	Poorly graded sands, little or no fines
SM	Silty sands
ML	Inorganic silts, liquid limit less than 50
CL	Inorganic clays, low to medium plasticity, liquid limit less than 50
MH	Inorganic silts, liquid limit greater than 50
CH	Inorganic clays, high plasticity, liquid limit greater than 50
OL	Organic silts or clays, low plasticity
OH	Organic silts or clays, liquid limit greater than 50
WL	Water level on date of boring

82-1M	Machine boring
Lt	Light
Dk	Dark
Br	Brown
Gr	Gray
Blk	Black

GENERAL NOTES

1. Moisture Content The natural moisture content (MC) in percent of dry weight is shown to the left of the boring log
2. Atterberg Limits Liquid limit (LL) and plastic limit (PL) are shown to the right of the boring log
3. Particle size Fine, medium and coarse soils are designated by the letters F, M and C to the right of the boring log
4. Dual Classification Where a soil is considered to be on the border line of two or more groups a double symbol is used i.e. (SP-SM)
5. D_{10} The grain size, in millimeters, of which 10% of the soil sample is finer
6. Blows Blow counts are shown to the left of the boring log and are the number of blows required to drive a standard $1\frac{3}{8}$" by 2" sampler a distance of 12 inches using a 140 lb hammer and 30" drop

Reference

1 Locations . . . . . Plate

DEPARTMENT OF THE ARMY

FEASIBILITY STUDY
WISCONSIN RIVER AT PORTAGE, WISCONSIN
BORING LOGS
82-9M THRU 82-13M

MARCH 1983

AS SHOWN

PLATE E

BORING NO. MB-1
SURFACE ELEV. 806.2 FT.

OWEN AYRES & ASSOCIATES, INC.
4111 SCHOFIELD AVENUE
SCHOFIELD, WI. 54476

SAMPLE NUMBER	BLOWS ON SAMPLER (140 lbs – 2" O.D. – FALLING 30") 6"	6"	per ft.	SAMPLE TYPE	CLASSIFICATION AND REMARKS	LAB TESTS	UNIFIED CLASSIFICATN	POCKET PEN READING (TSF)	GEOLOGY	DEPTH	ELEV.
1				A	SAND, DK.BRN, M-F, SILTY, ROOTS, FIBERS NOTED		SM		FILL		
2	5	3	8	X						5	
3	5	7	12	X	10.0					10	796.2
					SAND, LT.BRN, C-VF, W/CLAY LENSES		SP				
					11.0						795.2
					SAND, YELL-BRN, C-F		SP				
					14.0						792.2
4	4	5	9	X	SAND, LT.BRN, C-F, W/TRC. SMALL GRVL.		SP		ALLUVIUM	15	
5	3	4	7	X						20	
6	5	6	11	X						25	
7	5	8	13	X						30	
					EOB 31.5						774.7

— KEY —

C = ROCK CORE
A = AUGER SAMPLE
X = SPLIT SPOON
S = SHELBY TUBE

PROJECT Wisconsin River Levees, Columbia County
DATE(S) DRILLED December 19, 1979
LOCATION Lewiston Levee
GROUNDWATER: 10.5FT BELOW G.S. AT ELEV. OF 795.7
DRILLERS: R. Prueher JOB NO. T-101-02-091
S. Busko DATE December 27, 1979

BORING NO. MB-2
SURFACE ELEV. 794.8 FT.

OWEN AYRES & ASSOCIATES, INC.
4111 SCHOFIELD AVENUE
SCHOFIELD, WI. 54476

SAMPLE NUMBER	BLOWS ON SAMPLER (140 lbs – 2" O.D. – FALLING 30") 6"	6"	per ft	SAMPLE TYPE	CLASSIFICATION AND REMARKS	LAB TESTS	UNIFIED CLASSIFICAT'N	POCKET PEN READING (TSF)	GEOLOGY	DEPTH	ELEV.
1				A	Sand,Brn,C-F,W/Trc.Silt		SM				792.8
					2.0						
2				A	Sand,Brn,M-F,Silty,Approx.30% Fines,Sl.Organic Smell		SM		FILL		790.8
					4.0						
					Sand,Brn,C-F, W/Trc.Silt		SM				789.8
					5.0						
3	3	1	4	X	Sand,Brn,M-F, Silty,W/Thin Clayey Seams		SM				788.8
					6.0						
					Sand, Reddish-Brn, C-F		SP				784.8
					10.0					10	
4	2	4	6	X	Silt,Lt.Brn., M-F,Mottled, Organic Smell		ML				783.8
					11.0						
					Sand,White-Lt.Brn,M-F,Silty, Approx.15%Fines		SM				780.8
					14.0						
5	3	5	8	X							
					Sand, White-Lt.Brn, M-F		SP				
6	4	6	10	X						20	
7	6	5	11	X					ALLUVIUM		
8	0	0	0	X						30	
					33.0						761.8
9	9	14	23	X	Sand, Lt.Brn, VF		SP				
10	16	15	31	X						40	
11	15	24	39	X							
					EOB 46.5						748.3
										50	
										60	

— KEY —

C = ROCK CORE
A = AUGER SAMPLE
X = SPLIT SPOON
S = SHELBY TUBE

PROJECT Wisconsin River Levees, Columbia County
DATE(S) DRILLED December 20, 1979
LOCATION Portage Levee
GROUNDWATER: 8.0 FT BELOW G.S. ELEV. OF 786.8
DRILLERS: R. Prueher JOB NO. T-101-02-091
S. Busko DATE December 27, 1979

BORING NO. MB-3

SURFACE ELEV. 792.5 FT.

OWEN AYRES & ASSOCIATES, INC.
4111 SCHOFIELD AVENUE
SCHOFIELD, WI. 54476

SAMPLE NUMBER	BLOWS ON SAMPLER (140 lbs. – 2" O.D. – FALLING 30") 6"	6"	per ft	SAMPLE TYPE	CLASSIFICATION AND REMARKS	LAB TESTS	UNIFIED CLASSIF'N	POCKET PEN READING (TSF)	GEOLOGY	DEPTH	ELEV.
					TOPSOIL — 0.2						
1				A	SAND, RED-BRN, M-F, W/TRC. SILT		SM		FILL		
					4.5						788.0
2	1	2	3	X	SAND, BRN, F. GRAINED, SILTY		SM			5	787.0
					5.5						
					SAND, RED-BRN, M-F, W/TRC. SILT		SM				
					9.5						783.0
3	2	3	5	X	SILT		ML			10	782.0
					10.5						
					SAND, BRN, M-F		SP		ALLUVIUM		
4	4	5	9	X						15	
					16.0						776.5
					SAND, BRN, C-F		SP				
5	4	4	8	X						20	
					21.0						771.5
					SAND, BRN, F-VF		SP				
					24.0						768.5
6	6	6	12	X	SAND, BRN, C-M		SP			25	
					29.5						763.0
7	14	17	31	X	SILT, GRAY-BLACK, ORGANIC SMELL		ML			30	762.0
					30.5						761.5
					SAND, BRN, M-F		SP				
					31.0						761.0
					SILT, GRAY-BLACK		ML				
					EOB 31.5						

— KEY —

C = ROCK CORE
A = AUGER SAMPLE
X = SPLIT SPOON
S = SHELBY TUBE
=
=

PROJECT Wisconsin River Levees, Columbia County
DATE(S) DRILLED December 20, 1979
LOCATION Portage Levee
GROUNDWATER: FT. BELOW G.S. AT ELEV. OF none
DRILLERS: R. Prueher JOB NO. T-101-02-091
S. Busko DATE December 27, 1979

PLATE E-6

BORING NO. MB-4
SURFACE ELEV. 805.8 FT.

OWEN AYRES & ASSOCIATES, INC
4111 SCHOFIELD AVENUE
SCHOFIELD, WI. 54476

SAMPLE NUMBER	BLOWS ON SAMPLER (140 lbs – 2" O.D. –FALLING 30") 6"	6"	per ft	SAMPLE TYPE	CLASSIFICATION AND REMARKS	LAB TESTS	UNIFIED CLASSIFICATION	POCKET PEN READING (TSF)	GEOLOGY	DEPTH	ELEV.
1				A	SAND, RED-BRN, M-VF, W/TRC. SILT		SM		FILL		804.3
					1.5						
2				A	SAND, DK.BRN-BLK, M-VF, SILTY W/ORGANICS, MUCKY SEAMS		SM				
3	3	2	5	X						5	
					6.5						799.3
					SAND, RED-BRN, C-F		SP		ALLUVIUM		
4	9	10	19	X						10	794.8
					11.0						
					SAND, LT.BRN, M-F		SP				
5	4	4	8	X	15.0					15	790.8
					SAND, BRN, VC-F, W/TRC.SMALL GRVL.		SP				
6	4	6	10	X	20.0					20	785.8
					SAND,BRN.VC-F,W/TRC.SMALL GRVL, APPROX.15% FINES		SM				
					22.0						783.8
					SAND, BRN, VC-F, W/TRC.SMALL GRVL, VC SAND SEAM @ 31.0		SP				
7	10	9	19	X						25	
8	9	10	19	X						30	874.3
					EOB 31.5						

—KEY—
C = ROCK CORE
A = AUGER SAMPLE
X = SPLIT SPOON
S = SHELBY TUBE

PROJECT Wisconsin River Levees, Columbia County
DATE(S) DRILLED December 19, 1979
LOCATION Caledonia Levee
GROUNDWATER: 9.0 FT. BELOW G.S. AT ELEV. OF 796.8
DRILLERS: R. Prueher S. Busko
JOB NO. T-101-02-091
DATE December 27, 1979

BORING NO. MB-5
SURFACE ELEV. 799.6 FT.

OWEN AYRES & ASSOCIATES, INC
4111 SCHOFIELD AVENUE
SCHOFIELD, WI. 54476

SAMPLE NUMBER	BLOWS ON SAMPLER (140 lbs - 2" O.D. - FALLING 30") 6"	6"	per ft	SAMPLE TYPE	CLASSIFICATION AND REMARKS	LAB TESTS	UNIFIED CLASSIFICAT'N	POCKET PEN READINGS (TSF)	GEOLOGY	DEPTH	ELEV.
1				A							
					SILT, BLK, MUCKY W/M-VF SAND, ROOTS, FIBERS @ 5', SILTY MOTTLED F. SAND SEAM 10.5-11.0				FILL		
2	4	4	8	X			ML			5	
3	7	5	12	X						10	
					11.5						788.1
					SILT, BRN-BLK, SANDY		ML				
4	7	5	12	X						15	784.1
					15.5						
					SAND, GRAY-WHITE, F-VF, APPROX. 15% FINES, HIGHLY DILATANT		SM		ALLUVIUM		782.6
					17.0						
					SAND, GRAY-WHITE, F-VF		SP				
5	3	8	11	X						20	
6	8	7	15	X						25	
7	6	6	12	X						30	
					EOB 31.5						

— KEY —

C = ROCK CORE
A = AUGER SAMPLE
X = SPLIT SPOON
S = SHELBY TUBE

PROJECT Wisconsin River Levees, Columbia County
DATE(S) DRILLED December 19, 1979
LOCATION Caledonia Levee
GROUNDWATER: 10.5 FT. BELOW GS AT ELEV. OF 789.1
DRILLERS: R. Prueher JOB NO. T-101-02-091
S. Busko DATE December 27, 1979

SOIL CLASSIFICATION RECORD SHEET

[illegible]

SOIL CLASSIFICATION RECORD SHEET

[illegible]

SOIL CLASSIFICATION RECORD SHEET

[illegible]

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

FEASIBILITY STUDY
WISCONSIN RIVER AT PORTAGE, WISCONSIN
LAB TEST

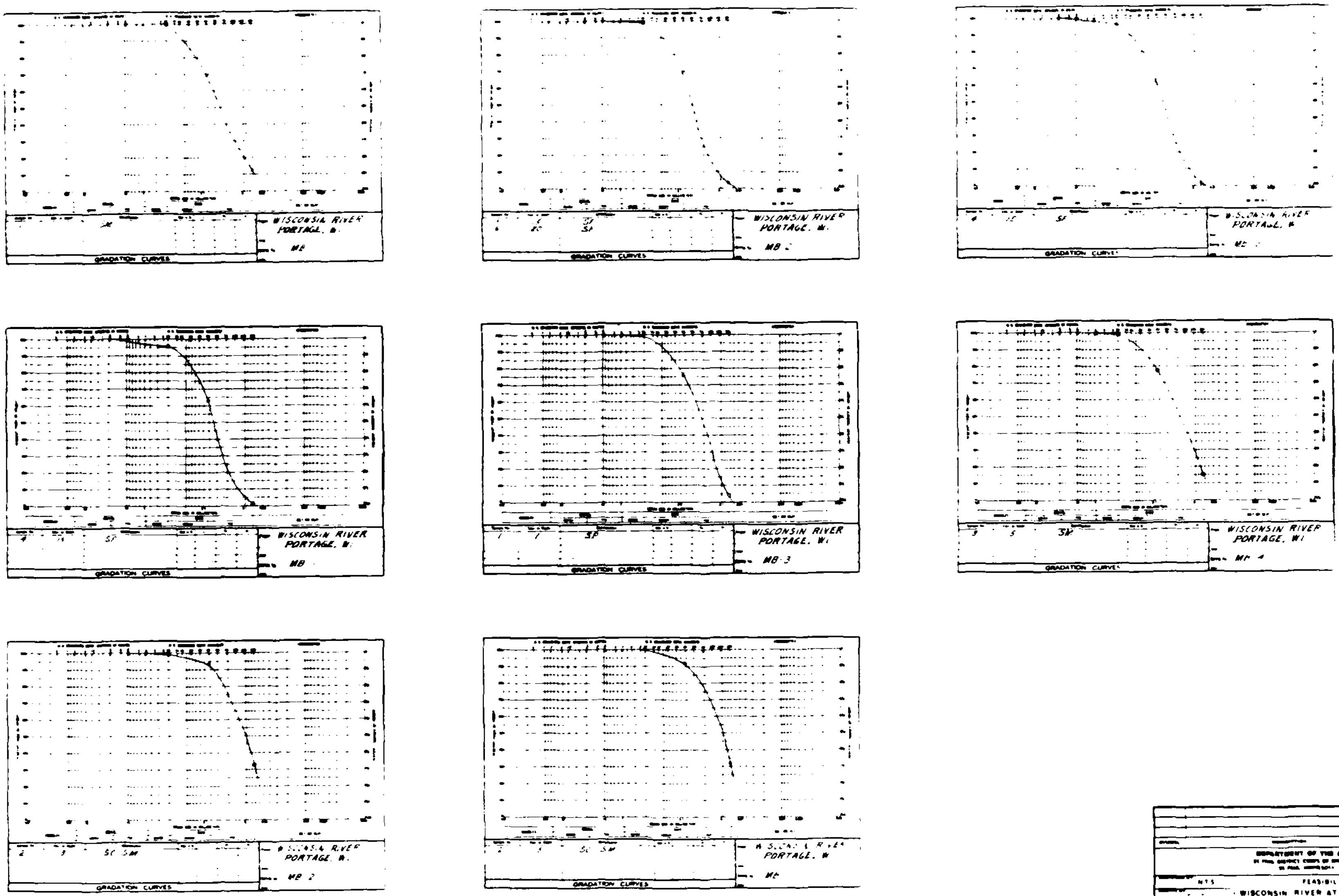
SUBMITTED BY

APPROVED

DATE
MARCH 1981

SHEET OF

PLATE E-4



DEPARTMENT OF THE ARMY

FEASIBILITY STUDY

WISCONSIN RIVER AT PORTAGE, WISCONSIN

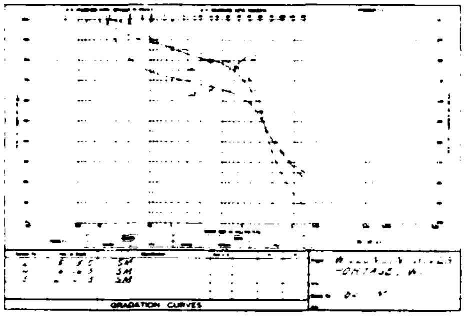
GRADATION CURVE

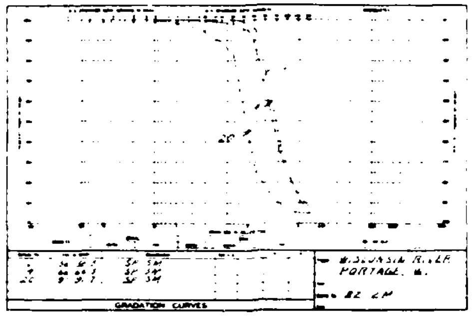
SUBMITTED BY

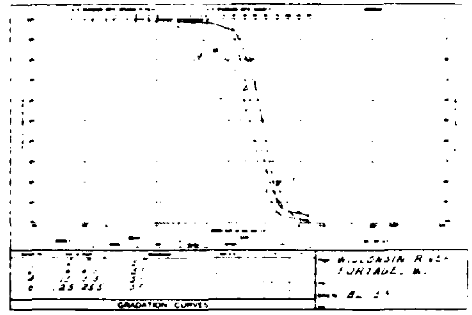
APPROVED

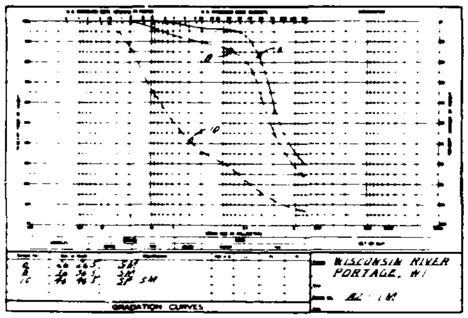
DATE MARCH 1983

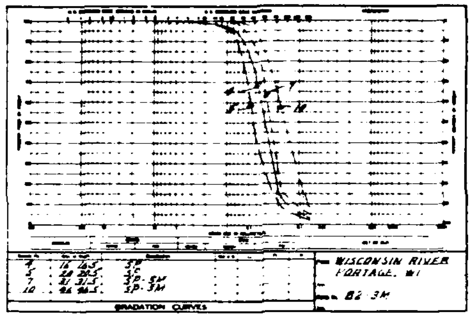
PLATE E-1[illegible]

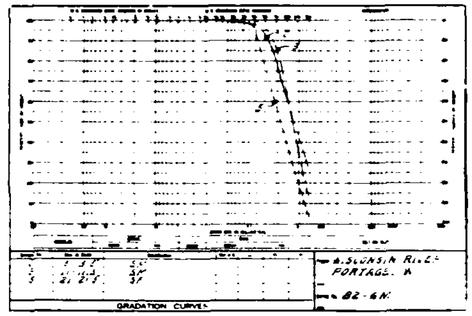


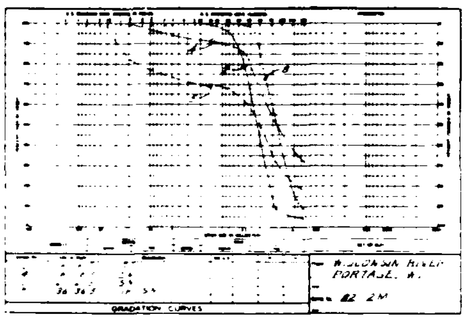


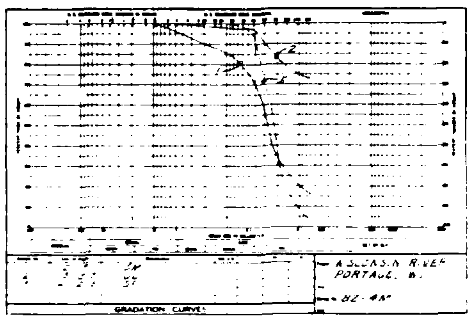












DEPARTMENT OF THE ARMY

WISCONSIN RIVER AT PORTAGE, WISCONSIN

GRADATION CURVES

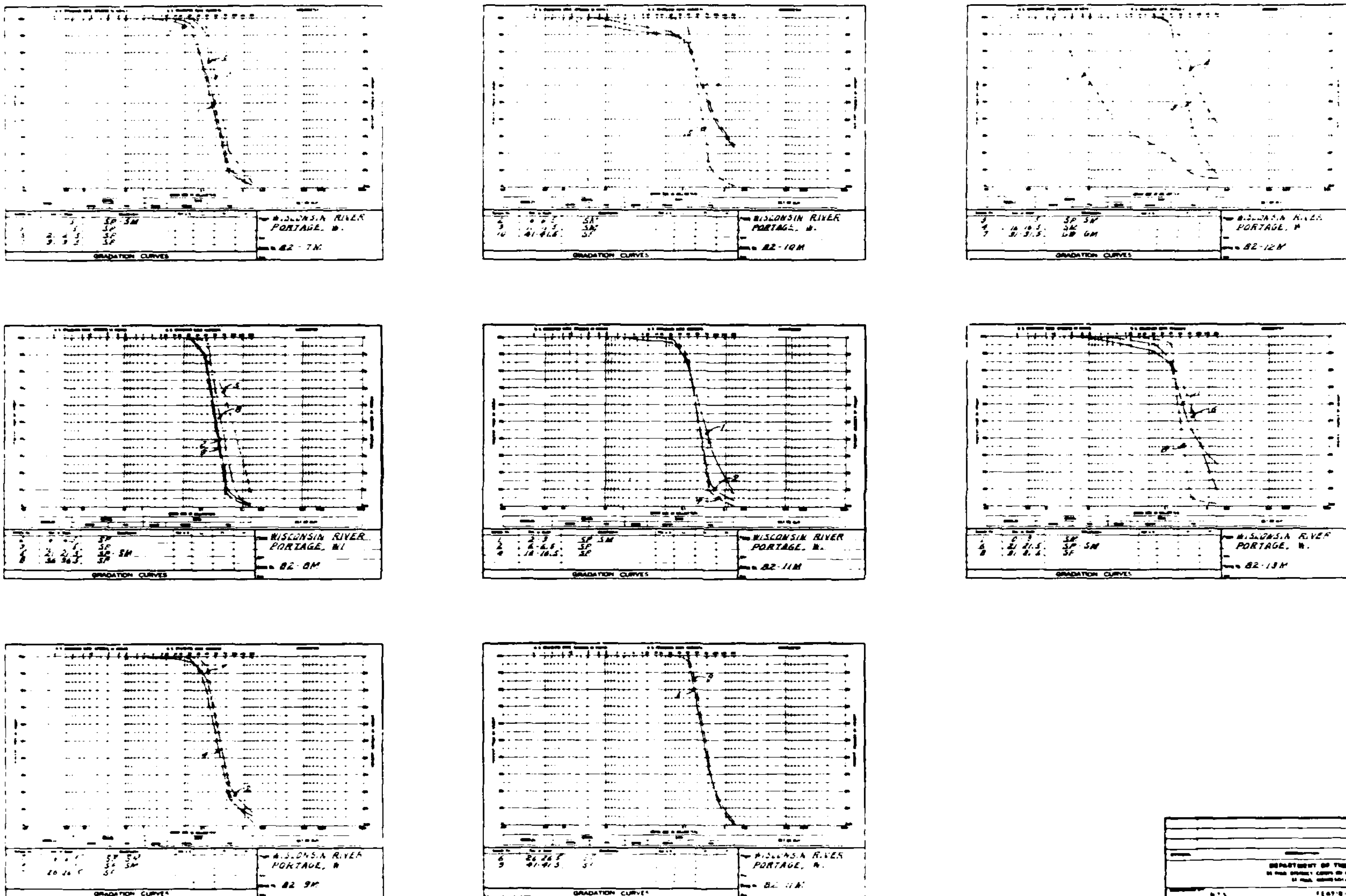
SUBMITTED BY:

APPROVED:

DATE

MARCH 1981

PLATE



DEPARTMENT OF THE ARMY

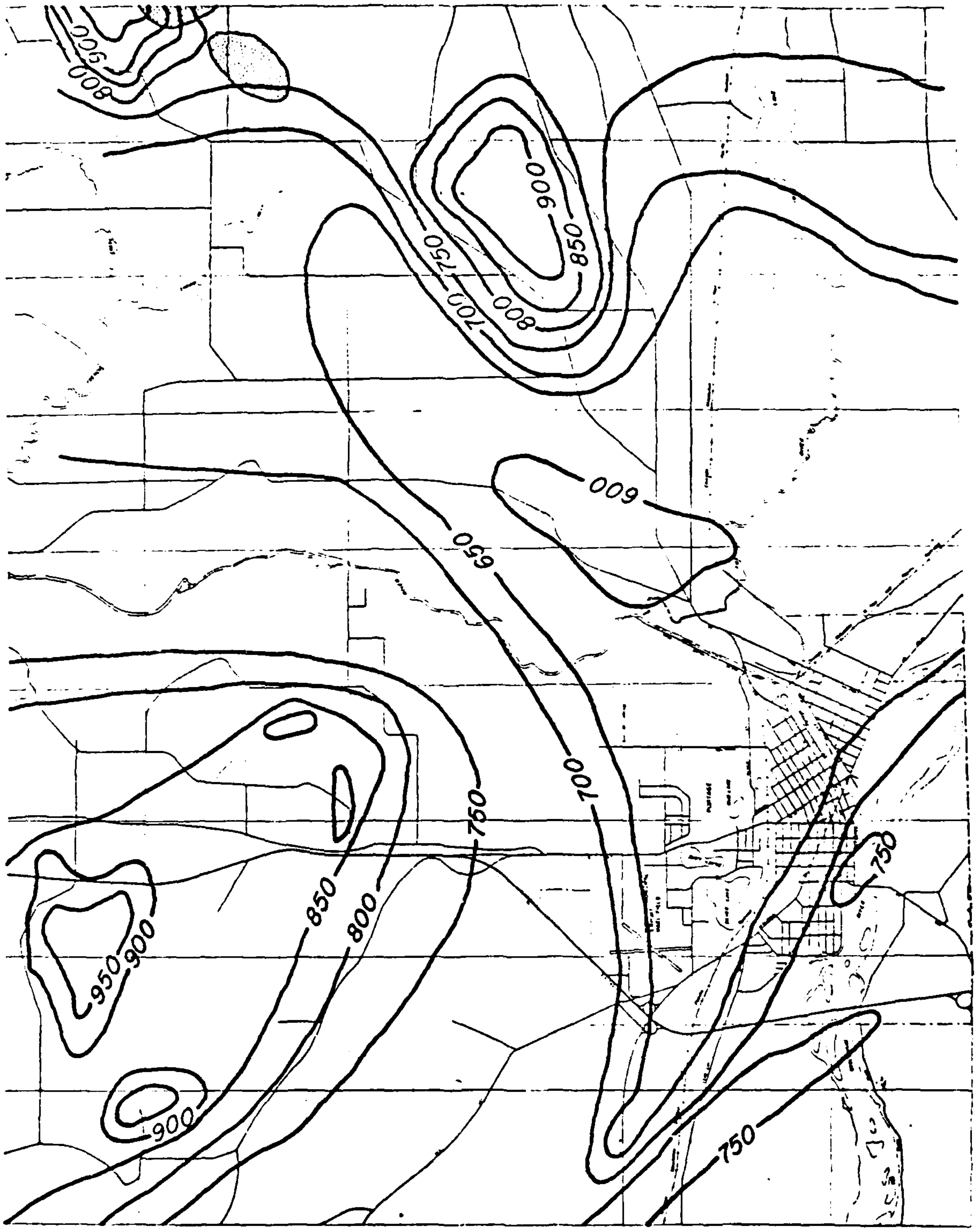
FEASIBILITY STUDY

WISCONSIN RIVER AT PORTAGE, WISCONSIN

GRADATION CURVES

MARCH 1981

PLATE E

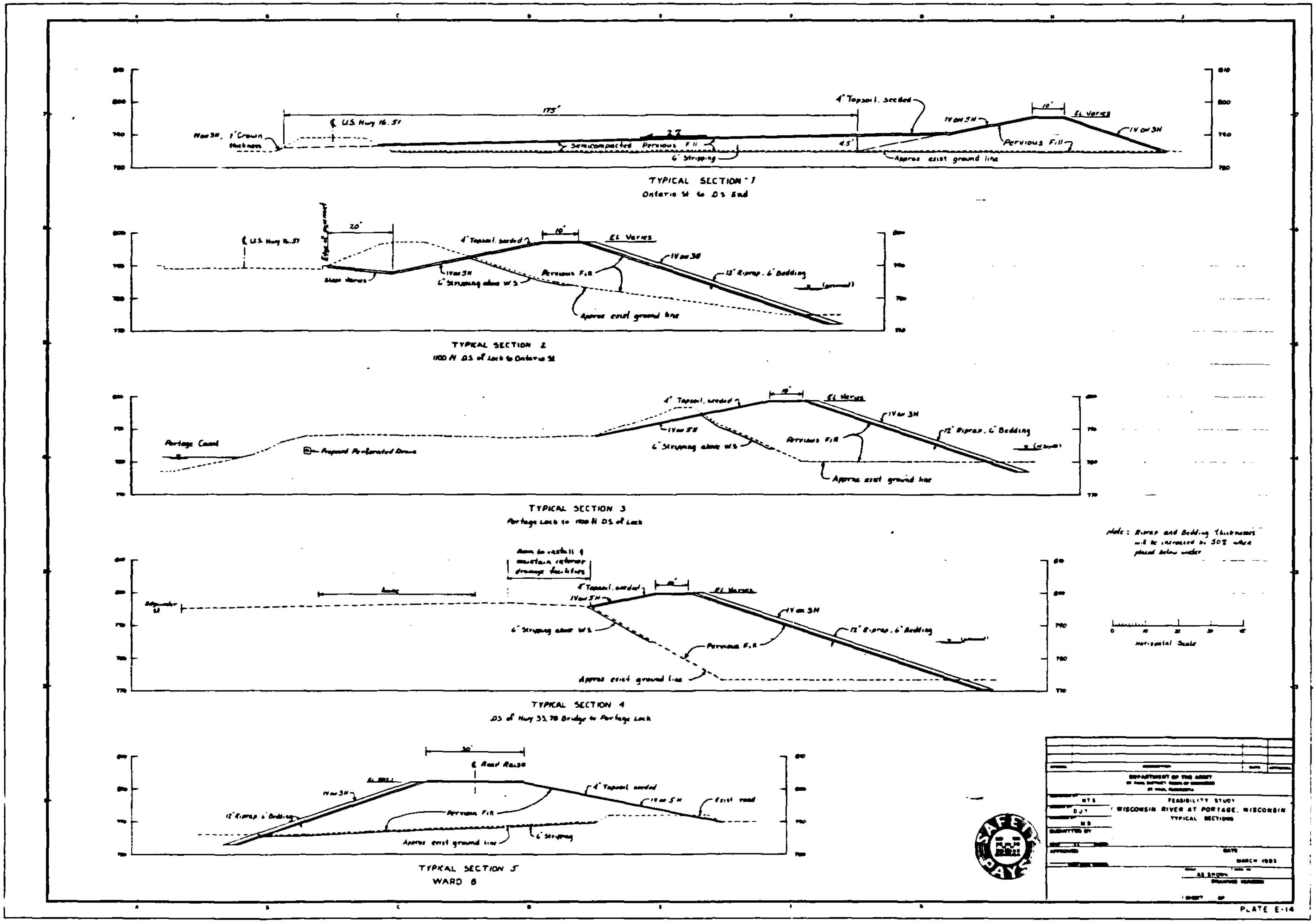


FEASIBILITY STUDY

WISCONSIN RIVER AT PORTAGE, WISCONSIN

TOP OF BEDROCK ELEVATION MAP

PLATE E-13


TYPICAL SECTION 1
Ontario St to D.S. End
4" Topsoil, seeded
1V on 5H
El Varies
1V on 3H
Pervious Fill
Semicompacted Pervious Fill
6" Stripping
Approx exist ground line
U.S. Hwy 16, 51
175'
10'
TYPICAL SECTION 2
1100 ft D.S. of Lock to Ontario St
4" Topsoil, seeded
El Varies
1V on 3H
12" Riprap, 6" Bedding
Pervious Fill
6" Stripping above W.S.
Approx exist ground line
Slope Varies
U.S. Hwy 16, 51
20'
10'
TYPICAL SECTION 3
Portage Lock to 1100 ft D.S. of Lock
Portage Canal
Proposed Perforated Drain
4" Topsoil, seeded
El Varies
1V on 3H
12" Riprap, 6" Bedding
Pervious Fill
6" Stripping above W.S.
Approx exist ground line
TYPICAL SECTION 4
D.S. of Hwy 33, 78 Bridge to Portage Lock
4" Topsoil, seeded
El Varies
1V on 3H
12" Riprap, 6" Bedding
Pervious Fill
6" Stripping above W.S.
Approx exist ground line
Note: Riprap and Bedding thicknesses will be increased by 50% when placed below water
Horizontal Scale
TYPICAL SECTION 5
WARD 8
Road Raise
30'
4" Topsoil seeded
1V on 5H
Exist road
12" Riprap, 6" Bedding
Pervious Fill
Approx exist ground line
6" Stripping
DEPARTMENT OF THE ARMY
FEASIBILITY STUDY
WISCONSIN RIVER AT PORTAGE, WISCONSIN
TYPICAL SECTIONS
MARCH 1983
AS SHOWN
PLATE E-14

FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER
at
PORTAGE, WISCONSIN

APPENDIX F

SOCIAL AND ECONOMIC ANALYSIS

December 1983

SOCIAL AND ECONOMIC ANALYSIS

TABLE OF CONTENTS

TABLES

PLATES

SOCIAL AND ECONOMIC ANALYSIS

INTRODUCTION

This appendix presents the socioeconomic environment at Portage, an estimate of flood damages incurred in Portage, and the national economic development benefits of measures proposed to reduce those damages. The socioeconomic profile includes a discussion ranging from background information on population to current information on industry and community growth. The benefit analysis was done in accordance with the ER 1105-2-40, 8 January 1982 and ER 1105-2-45, 11 January 1982.

DESCRIPTION OF THE AREA

Portage is located in Columbia County in south central Wisconsin. The primary study area (Ward 1) lies in the Wisconsin River floodplain and extends from the Columbia-Sauk County line near Lewiston Township, downstream through Portage to the Interstate 90-94 bridge.

The area around Portage is primarily agricultural, and the community serves as a regional service center. Over the past decades, employment has shifted from agriculture to manufacturing.

Portage is the largest community in Columbia County and has a current population of 7,896. It has seven major manufacturers, four of which are among the ten largest manufacturing employers in Columbia County. Portage also has four of the five largest nonmanufacturing employers (excluding public schools and public administration) in Columbia County.

POPULATION

The populations of Wisconsin, Columbia County, Portage, and Ward 1 for the years 1970 and 1980 are listed below.

Populations for 1970 and 1980

Year	Ward 1	Portage	Columbia County	State of Wisconsin
1970	702	7,821	40,150	4,417,731
1980	829	7,896	43,222	4,705,767
Percent change, 1970-1980	18.0	1.0	9.6	6.5

Source: 1970 and 1980 Census of Population, U.S. Bureau of the Census.

The following table presents population projections to the year 2000 for Portage, Columbia County, and Wisconsin.

Population projections

Year	Portage	Columbia County	State of Wisconsin
1985	NA	47,340	5,097,770
1990	8,560(1)	50,370	5,384,240
1995	NA	52,950	5,634,270
2000	8,790(1)	54,950	5,840,910
Percent change, 1985-2000	-	16	14.6

Source: EPA Environmental Impact Statement, Wastewater Treatment Facilities for Portage, Wisconsin, 1980.

(1)Past trend line of Portage as a percentage of Columbia County.

The two major forces behind population change are: (1) job opportunities and potential for employment growth, and (2) rate of natural population increase. Together they determine the magnitude of the population growth. More specifically, population is affected by birth rate, employment characteristics, migration and natural increases, commuting patterns, and available housing stock in the area.

LAND USE

A breakdown of land use in Portage is shown in the following table. Total developed and undeveloped land amounts to 7,239 acres.

Land use for Portage, 1978-2000

Year	Residential	Commercial	Industrial (1)	Institutl. & Utils.	Open Space	Total Dev. (2,3)	Undeveloped (4)
1978	882	224	262	248	133	1,749	5,490
1980	903	229	265	253	137	1,787	5,452
1985	955	242	274	267	144	1,882	5,357
1990	1,004	255	283	282	152	1,976	5,263
1995	1,057	268	293	296	160	2,074	5,165
2000	1,108	281	302	311	168	2,170	5,069

Source: EPA Environmental Impact Statement, Wastewater Treatment Facilities for Portage, Wisconsin, 1980.

(1) Includes 102 acres at the airport that is assumed to remain constant.

(2) It is assumed that the total amount of developed land increases by approximately 19 to 20 acres per year.

(3) Each category of developed land remains at a constant percentage of the totals; i.e., residential use is always approximately 50 percent of the total.

(4) Includes vacant land, natural areas, and agricultural lands.

Future land allocations, other than residential use, are difficult to predict for a city the size of Portage. Any number of factors may affect future land use allocations in the city.

Agricultural and natural lands are included in the undeveloped category in the table above. Agricultural lands include cultivated lands, pasturelands, and pine plantations. Natural areas include floodplain forests, oak-hickory forests, mixed succession forests, swamp forests, wetlands, and mixed grasslands.

The First Ward of Portage is made up of two major types of land - undeveloped and residential. Other parts of the ward are made up of vacant land (not being used at the present time), park lands, industrial lands, and public and institutional lands.

Previous land uses for Ward 1 (and Portage) were very similar except that the amount of vacant land has decreased. Although the amount of vacant land will continue to decrease, there are limiting factors. Most of the remaining land in the First Ward is swampy and unworkable because of the high water table and location in the Fox River floodplain.

Future residential development in Ward 1 may decrease over a 50- to 100-year planning period if the flood problems of the area are not resolved. In accordance with the zoning ordinance, additional residential growth in Portage should be located in the nonfloodplain section of the city. An area to the north, presently outside the city limits, appears to be developing for single-family and multi-family residential uses.

Employment status for persons of Portage and Columbia County for 1970 and 1980 is given below.

Employment status, Portage and Columbia County, 1970 and 1980

Item	Male 1970	Male 1980	Percent Change	Female 1970	Female 1980	Percent Change
Portage						
Civilian labor force	1,978	2,080	5.2	1,510	1,744	15.5
Employed	1,932	1,861	3.8	1,464	1,667	13.9
Unemployed	46	213	363.0	46	77	67.4
Not in labor force	574	688	19.8	1,577	1,574	0.19
Percent unemployed	2.3	10.2		3.0	4.4	
Columbia County						
Civilian labor force	10,231	11,893	16.2	5,983	8,554	42.9
Employed	9,978	10,958	9.8	5,657	7,991	41.3
Unemployed	253	935	270.0	326	563	72.7
Not in labor force	3,076	3,852	25.2	8,203	8,082	1.5
Percent unemployed	2.5	7.9		5.4	6.6	

Source: Demographic Services Center, Wisconsin Department of Administration

Unemployment rates have increased significantly for Portage and Columbia County from 1970 to 1980 because the area lost its largest employer, the Weyenberg Shoe Manufacturing Co., which closed in 1978. More recently, the Ray-O-Vac Division of ESB, Inc., which produces power cells for watches and hearing aids, laid off 120 employees in June 1980 and another 65 in August 1980. These employees were laid off indefinitely. Unemployment for men has increased more than that for women because the jobs that were lost were mainly factory work and/or retail trade, which have traditionally been male orientated occupations.

With the decline of employment in agriculture, forestry, and fisheries, manufacturing has become the dominant basic industry sector of the economy of Columbia County. A comparison of the 1975 employment data compiled by the Wisconsin Department of Industry, Labor, and Human Relations with the 1970 United States Bureau of the Census data indicates that manufacturing employment in Columbia County has been decreasing. Durable goods manu-

facturing employment decreased from 1970 to 1975, which explains the relatively high unemployment rate in Columbia County.

Development projects in the city of Portage will create some temporary and permanent jobs in 1983. At least 5 new jobs will be created by construction of the walk-through at the city parking ramp and 10 to 12 jobs will be created with the new shopping plaza. Temporary jobs will be created in construction of these projects.

Portage is a main manufacturing area in Columbia County. Four of the ten largest manufacturing employers are located in Portage. They are the Ray-O-Vac Corp., Medalist Industries, A.B.G. International, Ltd., and Portage Industries Corp. Also, four of the five largest nonmanufacturing employers in Columbia County are located in Portage. This excludes public schools and public administration. These employers are Divine Savior Hospital, which has from 300 to 349 employees; AMPI, 200 to 249 employees; Wisconsin Power and Light, 150 to 199 employees; and K-Mart, 100 to 149 employees. The following table shows major manufacturers in Portage in 1981.

Major manufacturers in Portage (1981)

Name	Product or Service	Total Employment	Percent Female	Year Established
Ray-O-Vac Div. of ESB	Power cells	400	80	1963
AMPI (Associated Milk Producers, Inc.)	Cheese	250	65	1950
Wisconsin Power Generating Station	Energy	170	3	1975
Penda Corp. ABG International	Plastics	160	30	1968
Medalists-Ripon	Hosiery	150	80	1878
Portage Industries, Inc.	Plastics	100	10	1954
H. Samuels Co.	Scrap metal	80	8	1948

Source: Community Profile of Portage, Wisconsin. Produced by the Wisconsin Department of Development, Madison, Wisconsin.

HOUSING

Portage is the third oldest community in Columbia County. The oldest portion of the city is the First Ward. Because of the age of this area and its floodprone conditions, a portion of the housing stock is deteriorating. In addition, a number of houses and apartment buildings are vacant. Attempts are currently being made to improve housing conditions in this area. Seventy percent of all of the housing rehabilitation funds and all of the proposed public works (which will be provided by HUD (the Department of Housing and Urban Development)) will be used in the First Ward.

Riverwood Apartments, a 61-unit apartment building for the elderly, was built by the city in 1981 and is located on West Mullet Street. The project is within walking distance of the entire downtown area, several area churches, and a park, and it has a beautiful view of the Wisconsin River and Portage Canal. New sidewalks, curbs, and gutters around the housing project are scheduled for completion in 1983.

Information on housing in Portage is given in the following table.

Housing data for Portage, Wisconsin

Portage	1970	1980
Number of housing units	2,831	3,308
Population in housing units	7,683	7,665
Per occupied unit	2.8	2.4
Owner	3.1	1.3
Renter	2.3	3.7
Units in structure		
1	1,990	2,132
2 or more	828	1,086
Mobile home or trailer	12	90

Source: General Housing Statistics, Wisconsin, U.S. Department of Commerce, Bureau of the Census.

OTHER DEVELOPMENTS

Sanitary sewer improvements and paving were completed in certain areas of the First Ward in 1982, and more improvements will be made in 1983. Sewer repairs were done on Washington Street and Dennings Road and paving was done on Washington Street. East Edgewater Street is scheduled for repair in 1983.

DOWNTOWN AREA

Two HUD-financed redevelopment projects are planned for Portage's downtown area. The first is the construction of a pass-through area from the city's parking ramp to fronts of the stores on the 200 block of West Cook Street. Plans for this project are being reviewed and construction is to be completed in 1983. The second project includes removing houses and expanding a warehouse located in the block of Dodge, Pauquette, and Wisconsin Streets to construct a new 36,000-square-foot building. The building will be used for retail and office space; the actual businesses have not been determined. The area will also be landscaped and adequate parking will be provided in the front and rear of the building. The residents of the houses to be removed will be relocated. This project will also start and be completed in 1983.

PORTAGE CANAL

No work is presently being done on the Portage Canal because of a lack of funds. The last work was done in the summer of 1981. Future plans for the canal include more brush cutting, bank stabilization, repair of the lock and dam, restoration of the lock tender's house, and development of a picnic area. The Portage Canal Society and an extension group from the University of Wisconsin have devised a proposal for the Wisconsin Department of Natural Resources to work on the canal.

ECONOMIC ASSUMPTIONS

The following economic assumptions were used in this report: a 100-year life, a discount rate of 8-1/8 percent, October 1983 prices, and the base-line hydraulic and economic conditions of no levees in place. No credit was taken for the emergency levees in Portage because of structural problems. Information about levee structures is given in the main report and in the geotechnical investigations and design appendix.

The damage-frequency curve was drawn using the water surface profile from the 1983 flood insurance study and flood damages determined by a field survey of the structures. The water surface profiles from the flood insurance study assume that the Lewiston, Caledonia, and Portage levees are not in place.

Flood damages for the study area have been estimated using a data base collected from 1978 to 1982. This information consists of inventory, interview, and survey. An initial inventory of all floodplain structures in Portage was compiled in January 1978. Building valuations, ground surface elevation, and first-floor elevations were recorded at that time. This information was then used with the St. Paul District's depth-damage computer program to determine damages at various elevations.

Commercial damages in Portage were evaluated through direct interview in the commercial and industrial establishments. Damages were determined at several elevations on each structure and damages were associated to each of these depths.

The economic rationale for fighting floods is that flood reduction measures would release those economic resources - land, labor and capital - used to fight floods and to repair or replace flood-damaged properties. Hence, damage reduction would benefit national economic development.

Flooding in Portage causes two types of economic damages: physical damages and emergency costs. Physical damages include damages to

flood plain structures and their contents and damages to roads, sewers, and other utilities. Emergency costs include costs of evacuation and reoccupation, flood fighting, and disaster relief. Income losses were not taken into account in Portage. No losses were found that could not be transferred to other areas.

FLOOD DAMAGE REACHES

Three different areas of the city of Portage are susceptible to flooding. These areas are divided into three reaches as shown on the map on plate F-11.

REACH 1

Reach 1 is located upstream of Highway 33. The area susceptible to flooding is bordered by Sunset Street, River Street, and the Wisconsin River. Eighteen residential structures would be damaged in this area during the 500-year flood. No new development is projected for this reach since the portions not in residential development are wetland areas.

Basement seepage damages begin at elevation 791 when water flows through the soil in the area and begins to soak through the basement walls and back-up the sewers. Water begins to flow directly into the structures at elevation 795.

REACH 2

Reach 2 is located between the Highway 33 bridge and the Portage Lock, and is bordered by Pierce, Conant, and Cass Streets and the Wisconsin River. Sixty-nine residential structures would be damaged from the 500-year flood. No undeveloped areas exist in this reach and no future land use changes are projected. Indirect damages were not taken in this area because the city has initiated construction which protects against seepage. Water will overflow the banks and begin to directly flood the structures at elevation 790.

REACH 3

Reach 3 is located downstream of the Portage Lock and includes the Ward 1 area of Portage. This area can be flooded directly from the Wisconsin River and indirectly from Wisconsin River overflows into the Fox River. The potential for the latter to occur exists during a standard project flood condition. Seepage damages in this area begin at elevation 784.5 in the area between the river and Highway 51. Direct flood flows begin at elevation 787.5. Floodwater has to reach elevation 789 to overtop Highway 51 and damage the rest of reach 3. During standard project flood flows, water in the Fox River reservoir area, which is the wetland between the Wisconsin and Fox Rivers, just downstream from reach 3, will reach an elevation where damages will occur.

Reach 3 contains two types of land use that sustain flood damage: commercial and residential. The rest of the area is now undeveloped. The majority of this undeveloped area will remain undeveloped because it is wetland. One area projected for future development is located between the railroad tracks (Fox River area) and Highway 51 and cross sections A-G and A-F. The city projected that the land use in this area will change to an industrial holding area.

Reach 3 contains 360 total structures. Of these, 283 are residential and 77 are commercial units. No future increase in the numbers of structures is expected. However, in 1982 a HUD Community Development Block Grant Program was initiated. This program will renovate some of the older homes in the Ward 1 area. Renovation will involve repair of foundation, sewers, and other general improvements to the residential structures. A limited number of homes with first floors near the 100-year level will be floodproofed.

The block grant program will not significantly change the residential damage analysis in Ward 1. Most of the homes in Ward 1 are from 1 to 4 feet below the 100-year floodplain. These elevations are too great to floodproof without large expense, and the work probably would not be done with the

block grant program. The homes, when renovated, will increase in market value. Because of the difficulty in gathering precise information on the amount of increase expected, no change in market value is projected during this phase of study. The affluence factor increase is the only future change that will be projected.

OTHER AREAS AFFECTED BY FLOODING

Other areas that can be flooded during the baseline conditions are: an agricultural area west of town near the Lewiston levee, several communities downstream on the Fox River, and an agricultural and urban area across the river called Blackhawk Park.

FLOOD DAMAGES

Portage begins to experience damages at 45,000 cfs (about the 5-year flood). Businesses and residences in Ward 1 begin to experience damage from seepage at this level regardless of whether the Portage levee is in place. Reaches 1 and 2 begin to experience damages at 60,000 cfs or at the 7-year flood level.

Portage damages increase rapidly when water overflows Highway 51 in the Ward 1 area at about the 10-year flood level. Damages increase much more slowly past this point because of a small increase in elevation. In the Ward 1 area, the 10-year elevation is 790.6 and the 500-year elevation is 792.0. A 1.4-foot increase in elevation causes only a 22-percent increase in residential damages in the Ward 1 area. The other reach areas show comparable increases. The following table shows damages and the numbers of structures flooded by reach and frequency.

Damages and number of structures flooded in Portage

Category	Zero damage	Flood Damages — Event: 8-year	10-year	50-year	100-year	500-year
Reach 1	7-year	$ 53,000	$ 76,000	$ 90,000	$ 96,000	$ 100,000
Reach 2	7-year	203,000	313,000	375,000	428,000	448,000
Reach 3 commercial	5-year	1,040,000	1,700,000	2,300,000	2,500,000	4,000,000
Reach 3 residential	5-year	417,000	3,690,000	4,300,000	4,400,000	4,700,000
Total		$1,713,000	$5,779,000	$7,065,000	$7,424,000	$9,248,000
Numbers of structures flooded						
Reach 1		10	14	16	17	18
Reach 2		32	48	58	66	69
Reach 3 commercial		20	31	42	46	77
Reach 3 residential		26	220	258	264	283
Total		88	313	374	393	447

The only historical flood that caused major damages was the 1938 flood. Damages during this flood were not tabulated and the city has changed much since 1938. Therefore, historical damages were not included in this report.

FUTURE FLOOD DAMAGES

Future changes in flood damages can be divided into two categories: residential and commercial. Residential damages are increased by the affluence factor, which is a projected rate of increase in damageable contents over time. Commercial damages are projected to remain constant over time because the number of commercial structures in the floodplain is not expected to change. Affluence factor increases cannot be used in determining future growth in commercial damages because of the lack of empirical evidence of the relationship of affluence changes and growth of damages.

Residential damages can increase from $514,000 to $925,000 from 1983 to 2043. The average market value per structure in the 500-year floodplain is $30,100. The average content value is about $7,500, based on an estimated content value of 25 percent of the value of the structures. This value comes from A Study of Procedure in Estimating Flood Damages to Residential, Commercial and Industrial Properties in California by the Stanford Research Institute. During the 500-year flood in Portage, 447 residential structures are expected to receive damages. The value of existing residential structures and contents in the 500-year floodplain is shown in the following table.

Value of residential structures in Portage

Number of structures	Total market value: Structure	Total market value: Contents	Average value per structure	Average value of contents
447	$13,473,000	$3,356,000	$30,100	$7,500

The OBERS regional projections for per capita income were used as the basis for increasing the real value of residential contents. As the affluence factor increases, the value of residential contents will also increase. The value of the residential contents is projected to increase with the per capita income growth rate until it reaches a maximum level of 75 percent of the value of the structure. This increase is the maximum allowable by regulation; the increase, however, would continue if this regulation were not in place. The projected maximum value of residential contents is expected to occur by the year 2032. After 2032, the value of contents will be held to that maximum level. Since the floodplains are now developed to their maximum, no new development is projected in the future.

OBERS (1980) data project per capita income to grow from $4,900 to $13,400 from 1983 to 2030. This is an increase of 2.7 in 47 years and equals a compound growth rate of per capita income of 2 1/8 percent per year. This number is found by obtaining the compound growth rate which most nearly equals 2.7 in 47 years. The present value of the contents is estimated at 25 percent of the structural value and by regulation cannot increase past 75 percent or past a factor of 3 (75 ÷ 25 = 3). The following table shows these relationships.

Growth of per capita income and residential content value

Growth rate of OBERS per capita income

Year	Per capita income
1983	$ 4,900
2030	$ 13,400

$13,400 ÷ $4,900 = 2.7 in 47 years = a growth rate of 2 1/8 percent

Growth of residential content value at a rate of 2 1/8 percent

Year	Years from present	Growth index
1983	0	1.0
Project 1993	10	1.2
2000	17	1.4
2034	51	3.0
2043	60	3.0

Growth will maximize in the year 2034.

The St. Paul District's depth-damage study has shown damages to contents and structures divided into 40 percent and 60 percent, respectively. Content damages can then increase at a rate of 2 1/8 percent as shown on the previous table. Residential damages will increase at the rate shown on the following table.

Future residential damages in Portage

	Year				
Item	1983	1993	2000	2034	2043
Structural damages	$309,000	$309,000	$309,000	$309,000	$309,000
Content damages	205,000	246,000	287,000	616,000	616,000
Total	$514,000	$555,000	$596,000	$925,000	$925,000
Content value index	1.0	1.2	1.4	3.0	3.0
Index of the total	1.0	1.08	1.16	1.8	1.8

AVERAGE ANNUAL DAMAGES

Average annual damages in Portage are projected to increase from $798,000 to $1,209,000 from 1983 to 2043. In the base year 1993, damages are $83[illegible],000. After the year 2034, the damages will remain steady throughout the life of the project. Average annual damages, including future conditions, are $954,000. This information is shown on the following table. Plates F-1 through F-10 contain 1983 average annual damages.

Present and future average annual damages in Portage

Item	Average annual damages: Year 1983	1993	2034	2043	2093	Increase 1993 to 2093	Equivalency factor	Equivalency increase	Total damages
Reach 1	$ 11,000	$ 13,000	$ 21,000	$ 21,000	$ 21,000	$ 8,000	0.31	$ 3,000	$ 16,000
Reach 2	45,000	48,000	80,000	80,000	80,000	32,000	0.31	10,000	58,000
Reach 3									
Residential	459,000	494,000	824,000	824,000	824,000	330,000	0.31	102,000	596,000
Commercial	284,000	284,000	284,000	284,000	284,000	0	-	0	284,000
Total	799,000	839,000	1,209,000	1,209,000	1,209,000				954,000
Index	1.0	1.05	1.51	1.51	1.51				1.2

AVERAGE ANNUAL BENEFITS

The selected plan would protect the city of Portage to the 500-year flood level with 3 feet of freeboard. Benefits fall into two categories: flood control and savings of the administration of flood insurance costs. Flood insurance benefits are $39 per policy X 125 policies = $ 5,000. Flood control benefits are $908,000 This gives a total benefit number of $938,000[1]. Flood control benefit analysis is shown on the following table.

Freeboard benefits can be taken for the Portage levee. By regulation, one-half of the benefits of the 3 feet of freeboard can be credited to the levee. This area will include the standard project flood. The freeboard benefit will be $8,000 of annual benefits.

At the 500-year flood level, water will flow around the project levee and begin to flood the city from the Fox River overflows. Flooding in Portage at the standard project flood level is shown on plate 5 of the main report.

[1] Including recreation benefits identified in appendix H.

Benefits and residual damages from the selected plan

Item	Year 1983	1993	2034	2043	2093	Increase 1993 to 2093	Equivalency factor	Equivalency increase	Total benefits and damages
Reach 1	$ 10,000	$ 11,000	$ 16,000	$ 16,000	$ 16,000	$ 5,000	0.31	$ 2,000	$ 13,000
Reach 2	43,000	45,000	65,000	65,000	65,000	20,000	0.31	6,000	51,000
Reach 3									
Residential	440,000	475,000	792,000	792,000	792,000	317,000	0.31	98,000	573,000
Commercial	271,000	271,000	271,000	271,000	271,000	0	-	0	271,000
Total	764,000	809,000	1,144,000	1,144,000	1,144,000	342,000		106,000	908,000
Residual damages	35,000	37,000	65,000	65,000	65,000	28,000	0.31	9,000	46,000

BENEFIT-COST ANALYSIS

The benefit-cost ratio of Portage is 1.4 for existing and future conditions. The benefit-cost ratio for existing conditions alone is 1.2. Analysis is shown below. The benefit table shows 1983 benefits at $794,000 and existing and future benefits at $938,000.

Benefit-cost analysis

Costs for the selected plan

	First costs	$7,238,000
	Interest during construction	
	Year 1 (F.C. X 0.3 X 1.0394)	2,257,000
	Year 2 (F.C. X 0.7 X 1.1212)	5,681,000
=	First costs + interest during construction	$7,938,000
X	I & A at 8 1/8%	0.08128
=	Average annual costs	$ 645,000
+	O&M	10,000
=	Total annual costs	$ 655,000

Item	Existing conditions	Existing & future conditions
Benefits	$ 794,000 (1)	$ 938,000 (1)
Costs	655,000	655,000
Benefit-cost ratio	1.2	1.4

(1) Includes recreation benefits as presented in Appendix H.

BREAKEVEN RATE OF RETURN

The rate of return where the benefit-cost ratio is 1.0 is 10 3/4 percent as shown on the following table.

Breakeven rate of return

Benefits		Costs	
1990 benefits	$802,000	First costs	$7,238,000
Increase in benefits, 1993-2093	342,000	Interest during construction	
Equivalency factor at 10 1/2 percent	0.26	Year 1 (F.C. X .3 X 1.054)	2,289,000
Equivalent increase	89,000	Year 2 (F.C. X .7 X 1.114)	5,644,000
Total benefits	$891,000	Total	$7,933,000
		X interest & amortization	0.1075
		= average annual costs	$ 853,000
		+ operation & maintenance costs	10,000
			$ 863,000
$891,000/$863,000 $\cong$ 1.03			

SENSITIVITY ANALYSIS OF EXISTING PORTAGE LEVEES

A sensitivity analysis was conducted to determine the effects on project feasibility if the existing levees are credited with providing partial flood protection to the city of Portage. A breakeven approach was used to identify the maximum flood elevation which the Portage levee could be assumed to withstand and still yield a positive benefit-cost ratio for the selected plan.

Three alternative water surface profiles were generated for the analysis, assuming different scenarios of performance for the Caledonia, Lewiston, and Portage levees. Alternative A assumes that the Portage levee is in place and that the Caledonia and Lewiston levees are not. This alternative yields the lowest stage-frequency relationships in the channel, since it assumes that the Caledonia and Lewiston levees would provide no restrictions to overbank flow.

Alternative B assumes that the Portage, Lewiston, and Caledonia levees are all in place. This alternative yields the highest stage-frequency relationships since the three levee systems would restrict most flows to the channel. Alternative C assumes that the Portage levee would hold and that the Caledonia and Lewiston levees would breach at some low frequency event. This alternative yields somewhat higher stage-frequency relationships than alternative A and is considered the most likely scenario for performance of the Caledonia-Lewiston levee systems (see the main report for additional discussion).

All three alternatives were used in the analysis, resulting in three different breakeven elevations, as shown in the following table. In addition to performance of the existing levee systems, three other assumptions were made in the analysis: (1) top of the existing levee is at a constant elevation of 795.8; (2) three feet of freeboard is required to guarantee performance, making the effective levee height 792.8; and (3) potential damages in reaches 1 and 2 are not affected by the levees.

Breakeven elevations for alternative water surface profiles

Alternative	Breakeven elevation	Exceedence frequency	Benefit-cost ratio
A	790.4	6	1.06
B	(1)	-	(2)
C	790.8	2	1.06

(1) Breakeven elevation for alternative B is in excess of the effective levee height of 792.8.
(2) Was not calculated, but would be equal to, or greater than, the project benefit-cost ratio.

In summary, if alternative A was used, the existing Portage levee could be credited with providing protection to elevation 790.4 and still yield a feasible project. If alternative B is used, project feasibility would not be lost, even if the levee were credited to its maximum elevation. Finally, if the most likely scenario, alternative 3, is used, the levee could be credited with protecting to elevation 790.8, and still show a feasible benefit-cost ratio for the selected plan.

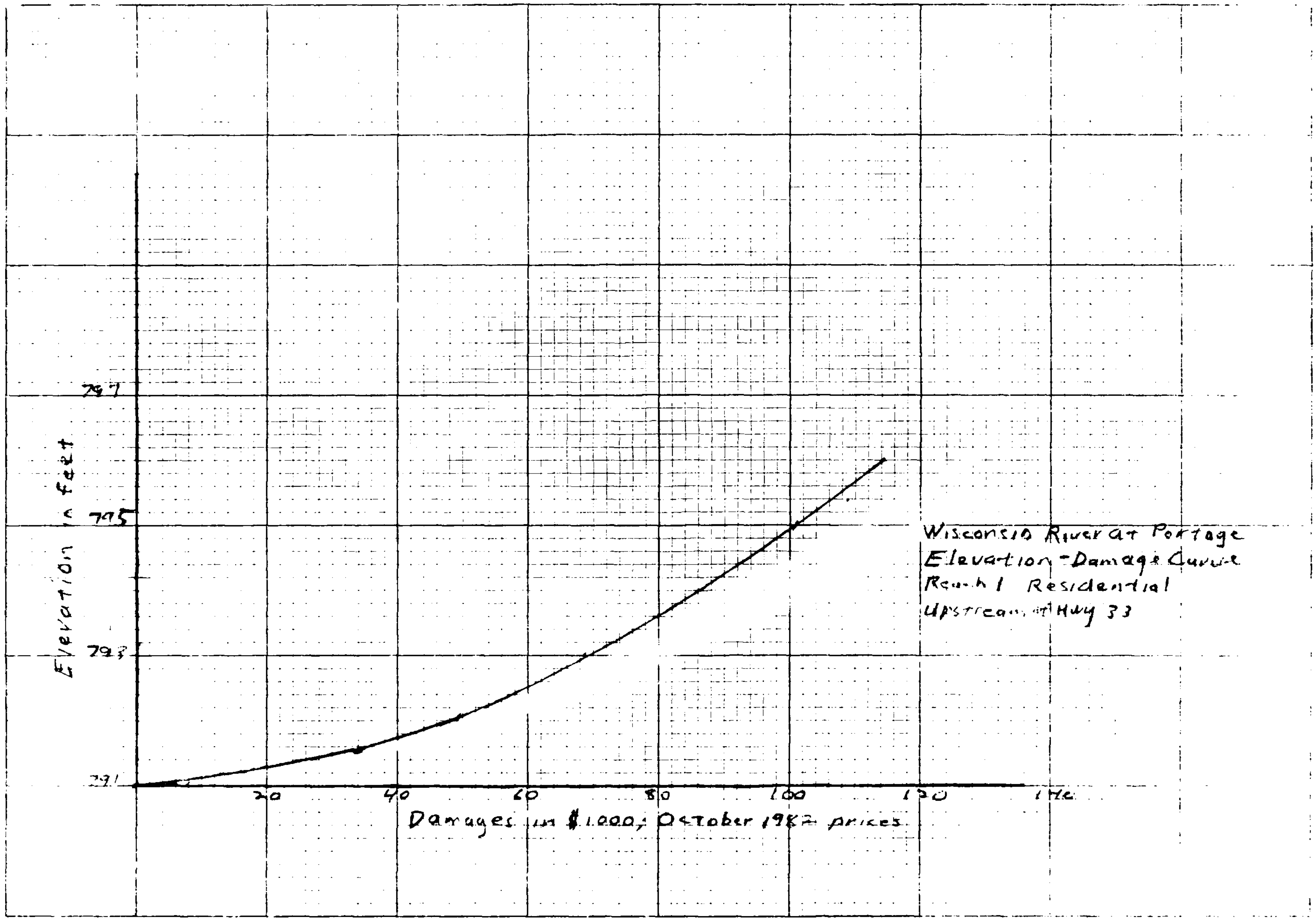

Wisconsin River at Portage
Elevation-Damage Curve
Reach 1 Residential
Upstream Hwy 33
Elevation in Feet
797
795
793
791
20
40
60
80
100
120
140
Damages in $1,000; October 1982 prices

PLATE F-1

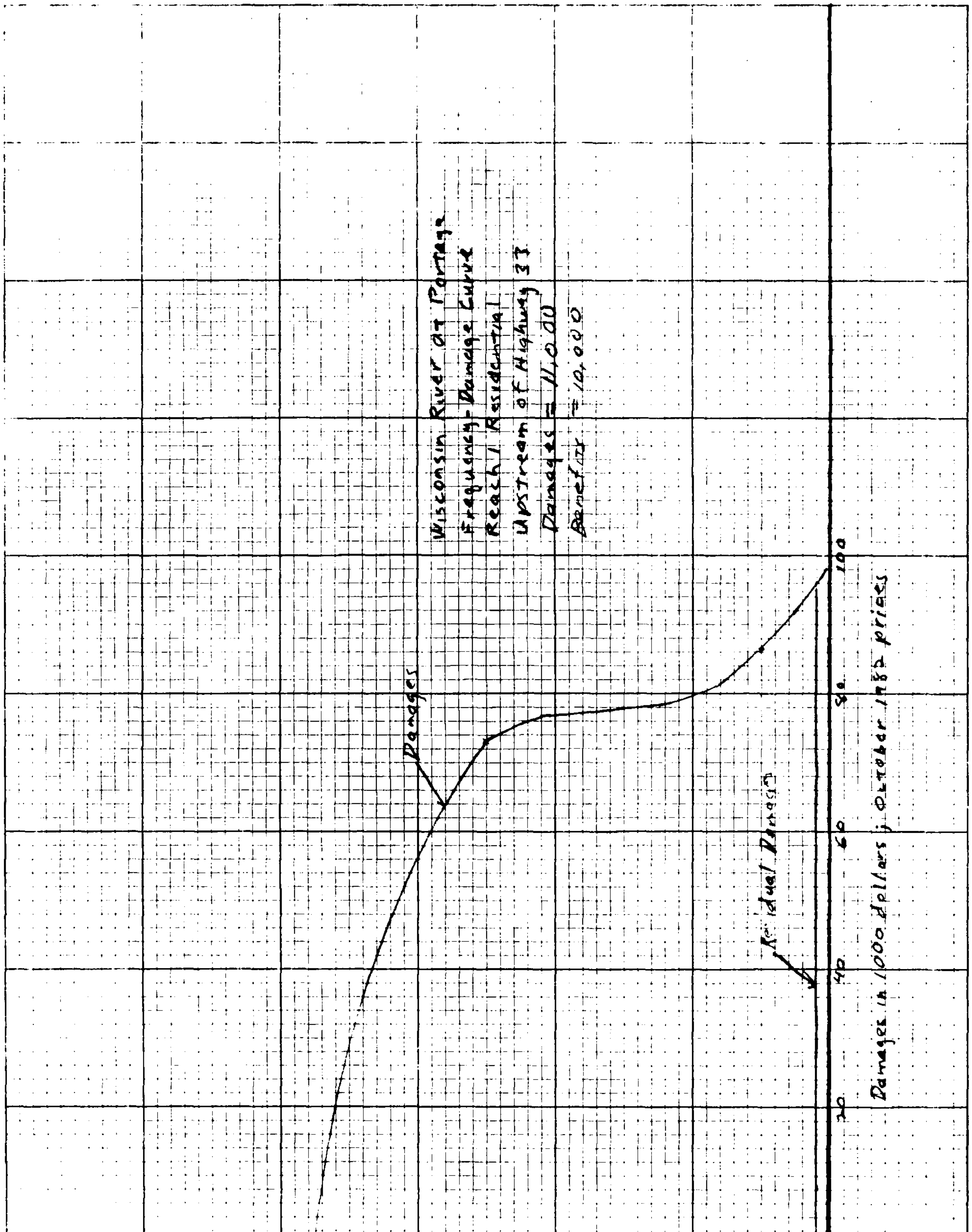
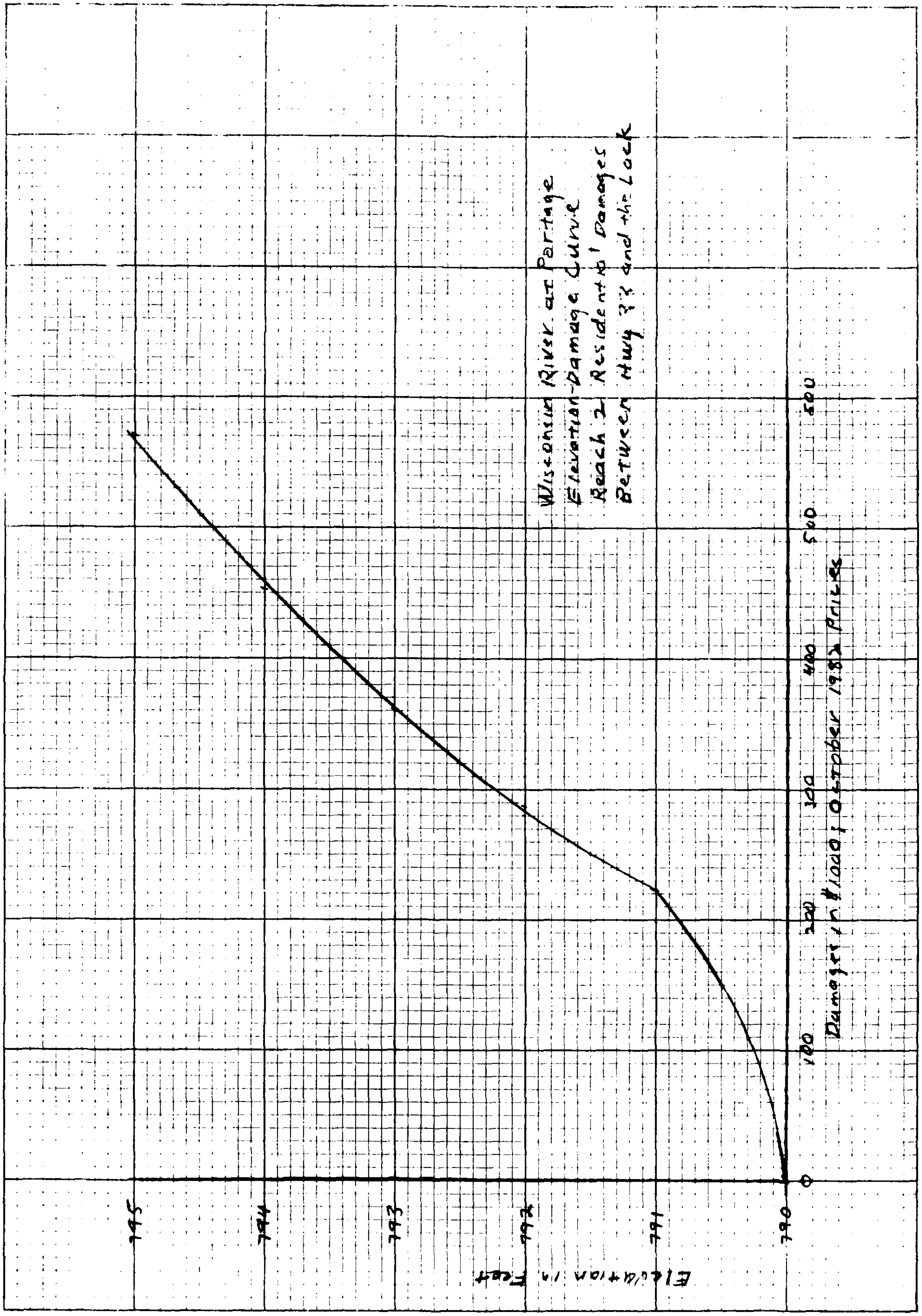

Wisconsin River at Portage
Frequency-Damage Curve
Reach I Residential
Upstream of Highway 33
Damages = 11,000
Benefits = 10,000
Damages
Residual Damages
Damages in 1000 dollars, October 1982 prices
0
20
40
60
80
100
Frequency in Percent
0
4
8
12
16

PLATE F-2



Wisconsin River at Portage
Elevation-Damage Curve
Reach 2 Residential Damages
Between Hwy 33 and the Lock
Damages in $1000, October 1982 Prices
0
100
200
300
400
500
600
Elevation in Feet
790
791
792
793
794
795

PLATE F3

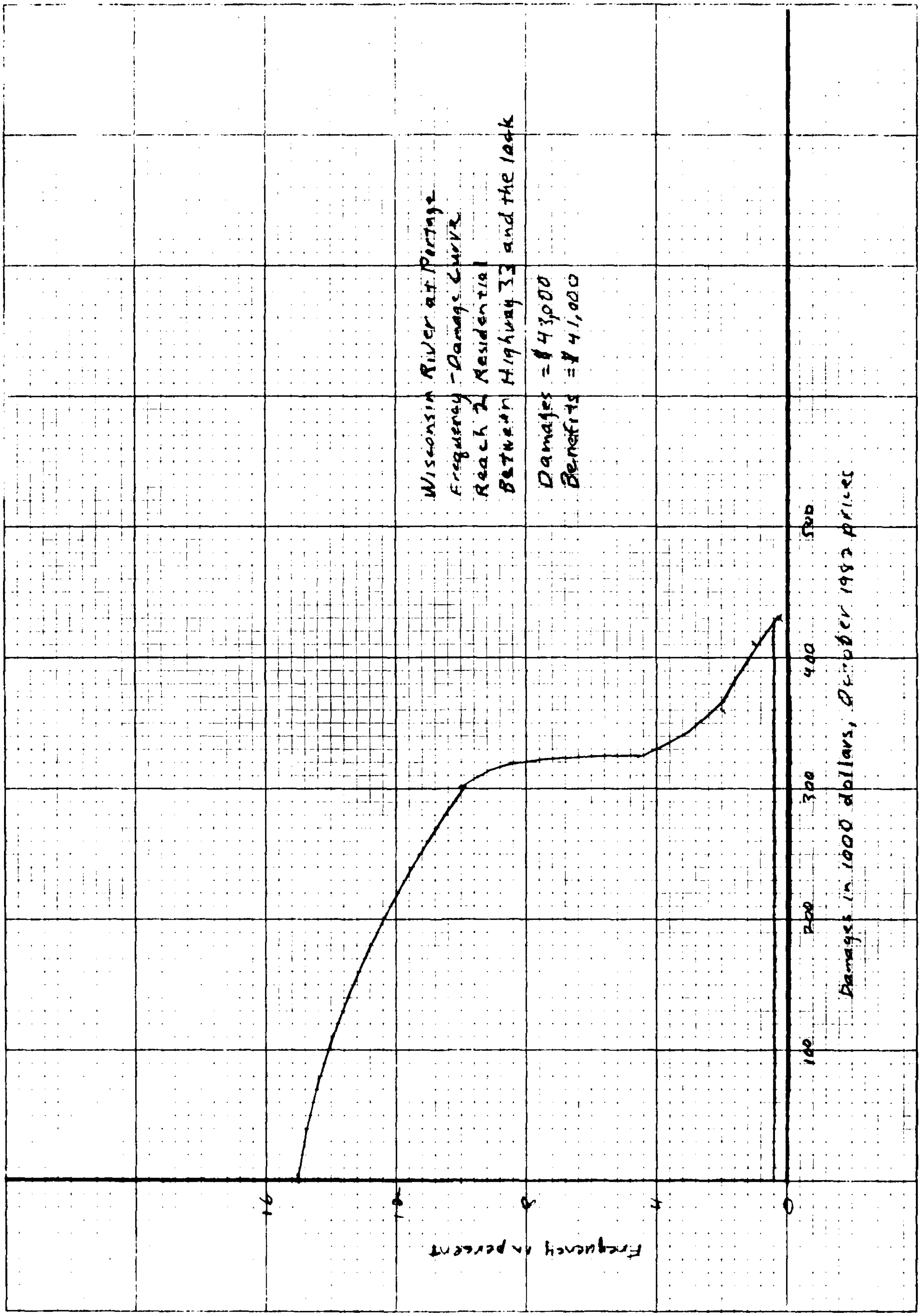

Wisconsin River at Portage
Frequency - Damage Curve
Reach 2 Residential
Between Highway 33 and the lock
Damages = $43,000
Benefits = $41,000
Damages in 1000 dollars, October 1982 prices
100
200
300
400
500
Frequency in percent
0
4
8
12
16

PLATE F-4

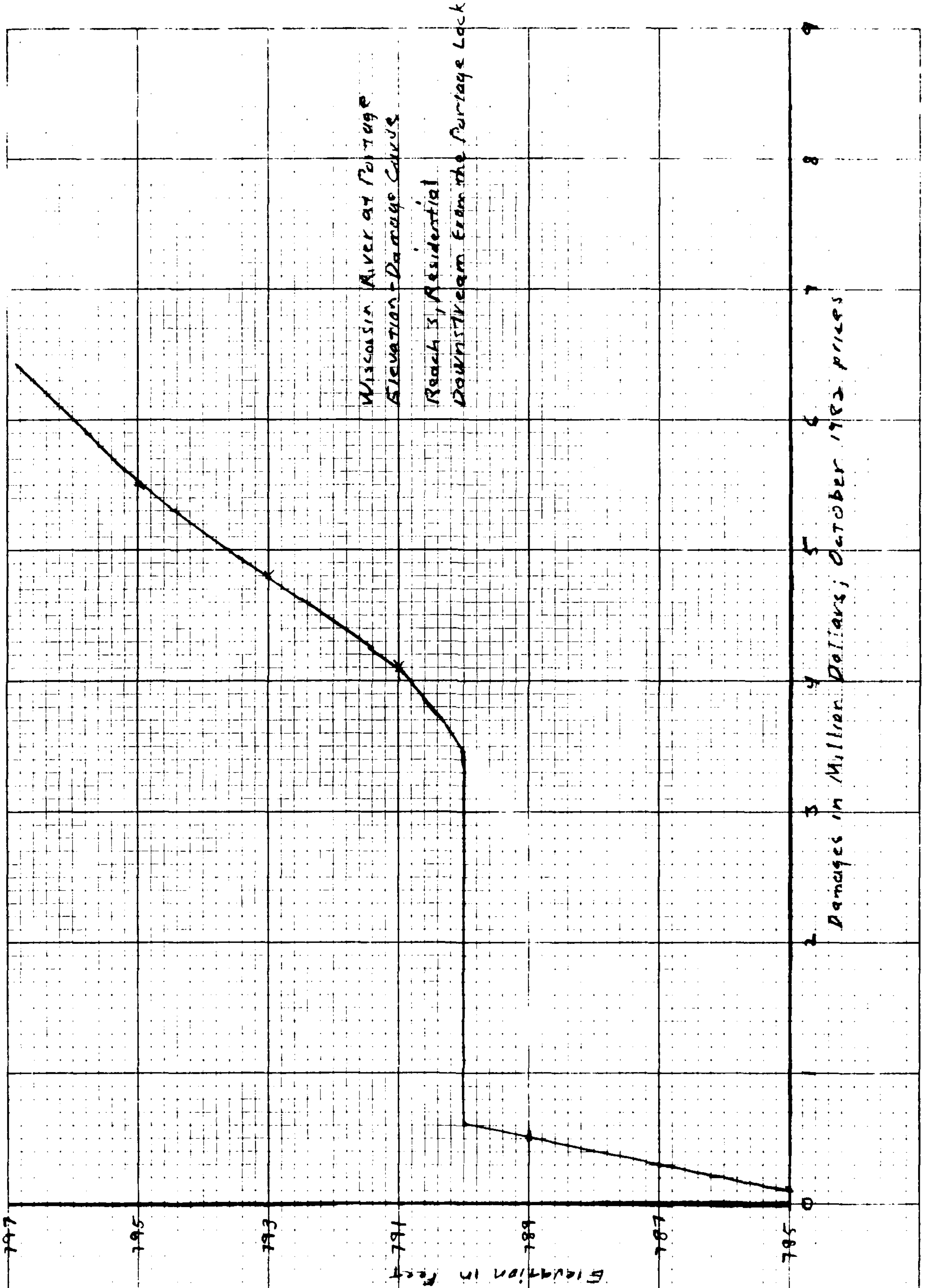

Wisconsin River at Portage
Elevation-Damage Curve
Reach 3, Residential
Downstream from the Portage Lock
Damages in Million Dollars; October 1982 prices
Elevation in Feet
785
787
789
791
793
795
797
0
2
3
4
5
6
7
8
9

PLATE F-5

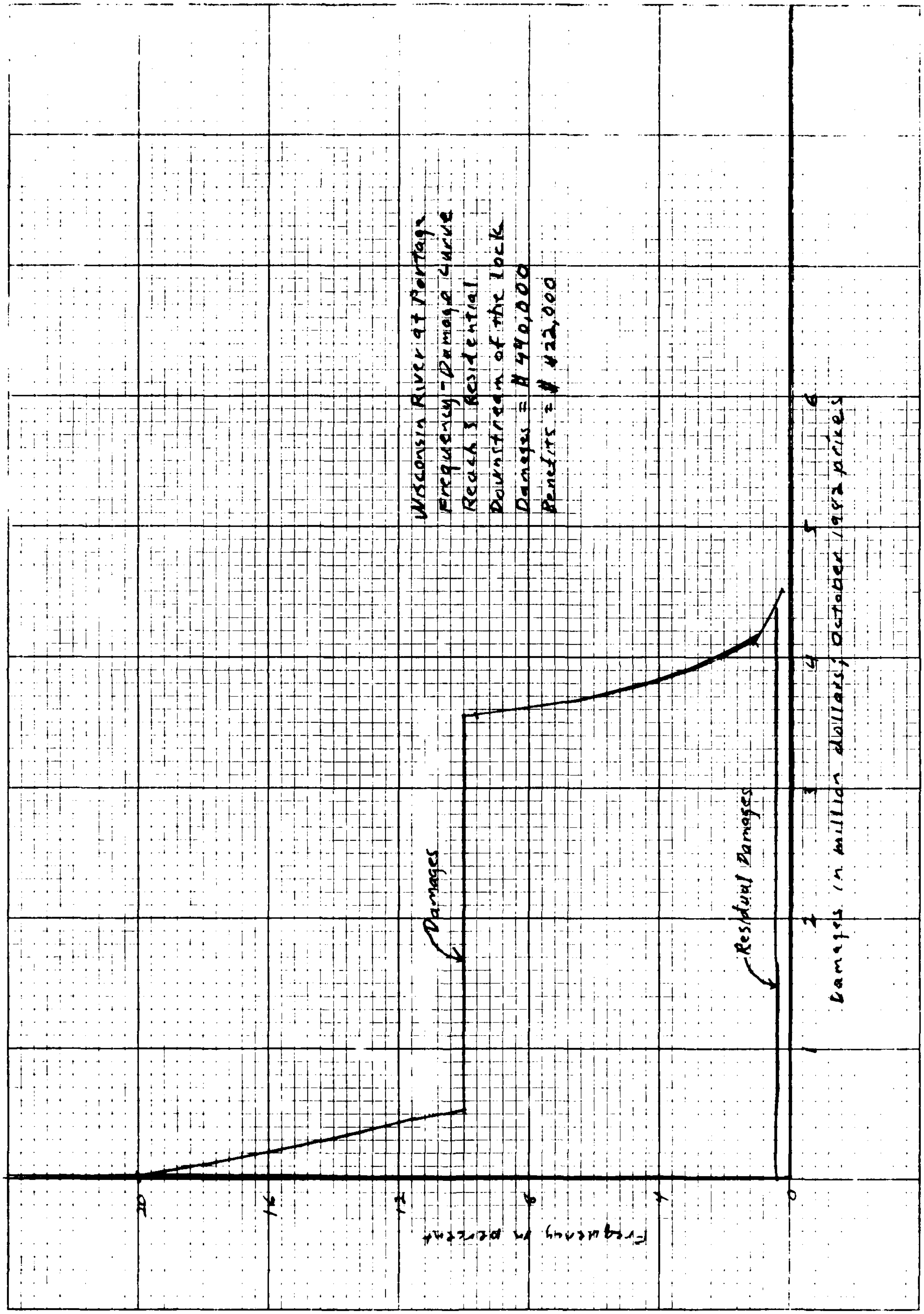
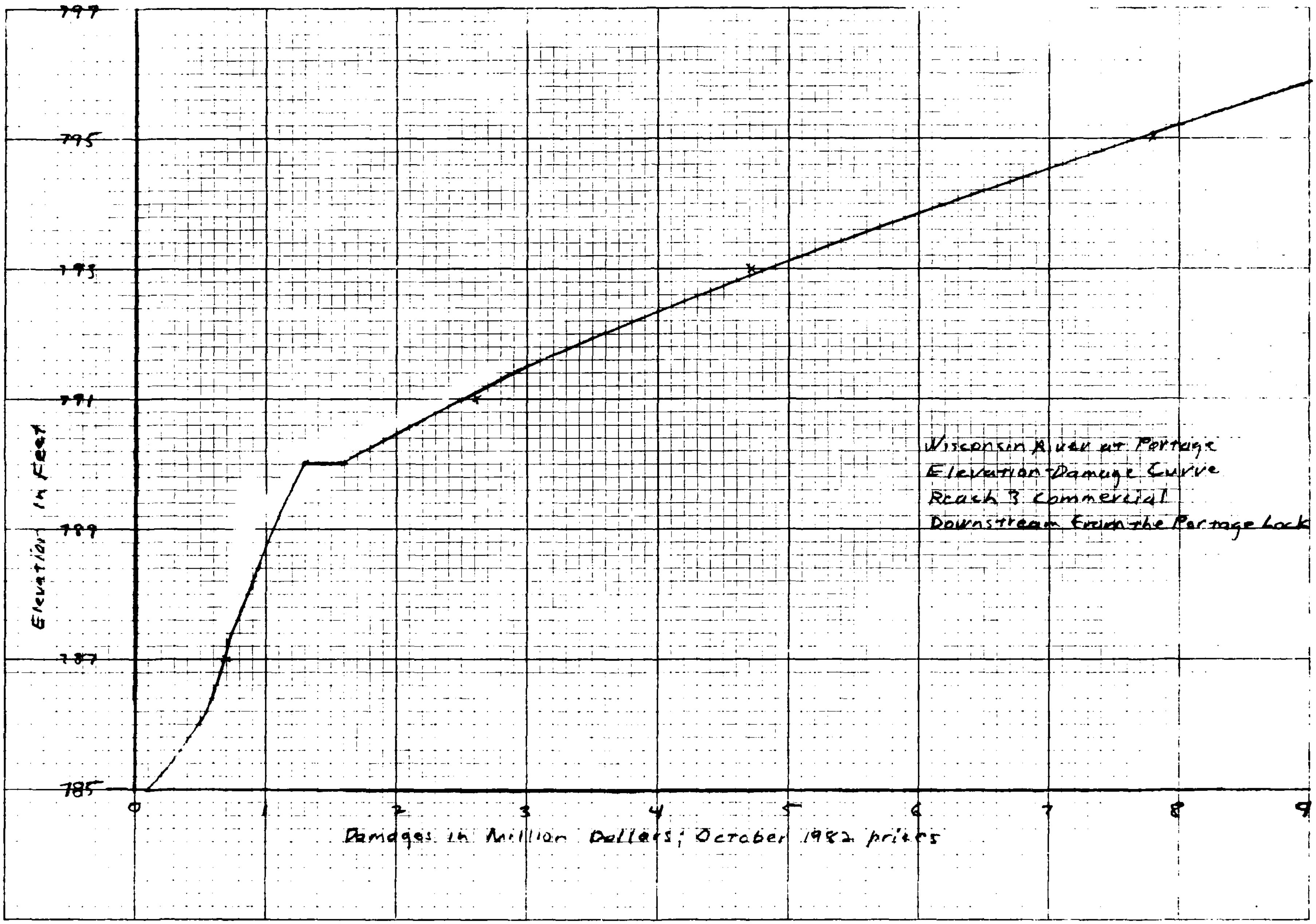

Wisconsin River at Portage
Frequency-Damage Curve
Reach 3 Residential
Downstream of the Lock
Damages = $490,000
Benefits = $422,000
Damages
Residual Damages
Damages in million dollars, October 1952 prices
0
1
2
3
4
5
6
Frequency in percent
0
4
8
12
16
20

PLATE F-6



Wisconsin River at Portage
Elevation-Damage Curve
Reach 3 Commercial
Downstream From the Portage Lock
Elevation in Feet
797
795
793
791
789
787
785
0
1
2
3
4
5
6
7
8
9
Damages in Million Dollars; October 1982 prices

PLATE F-7

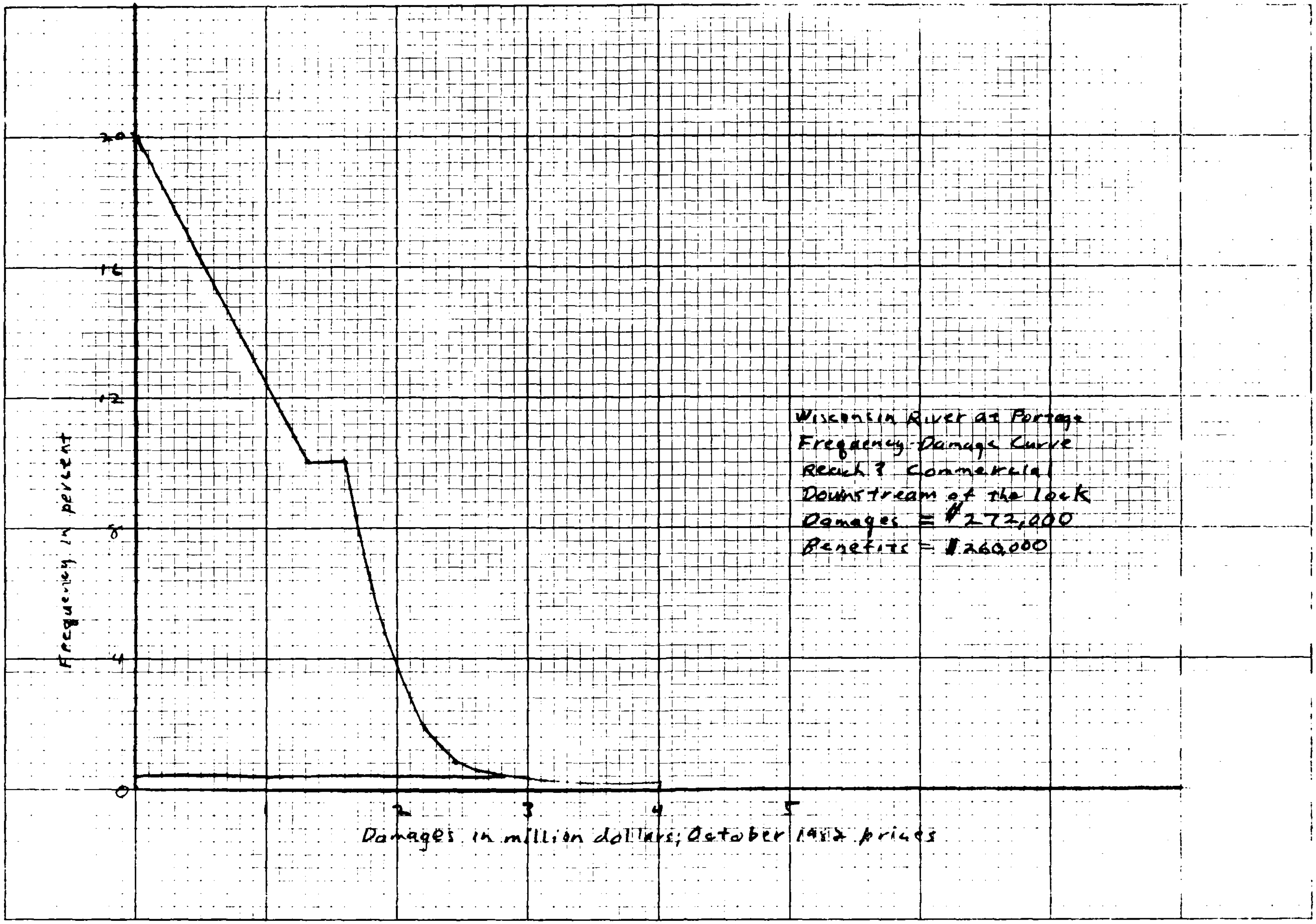
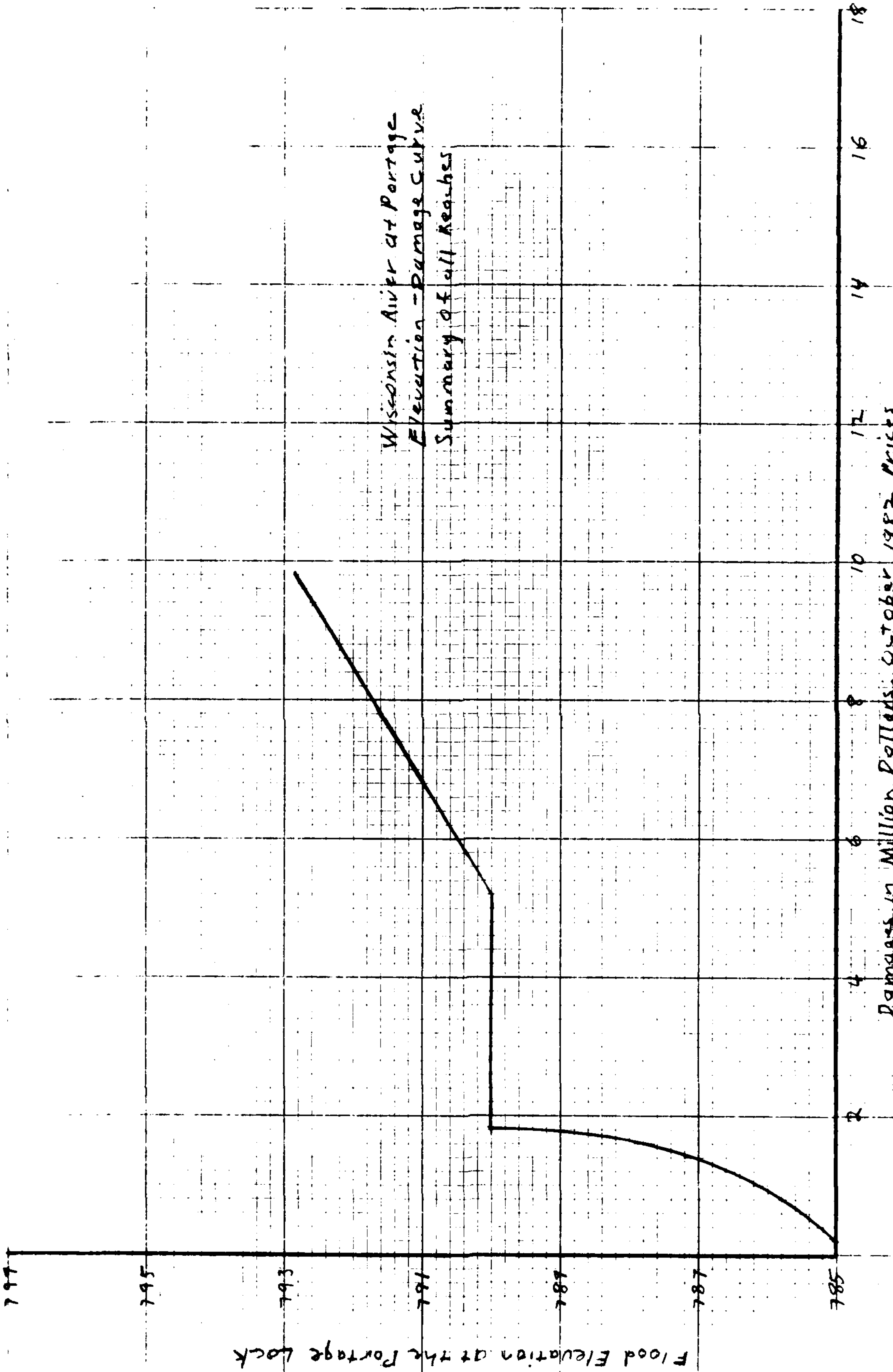
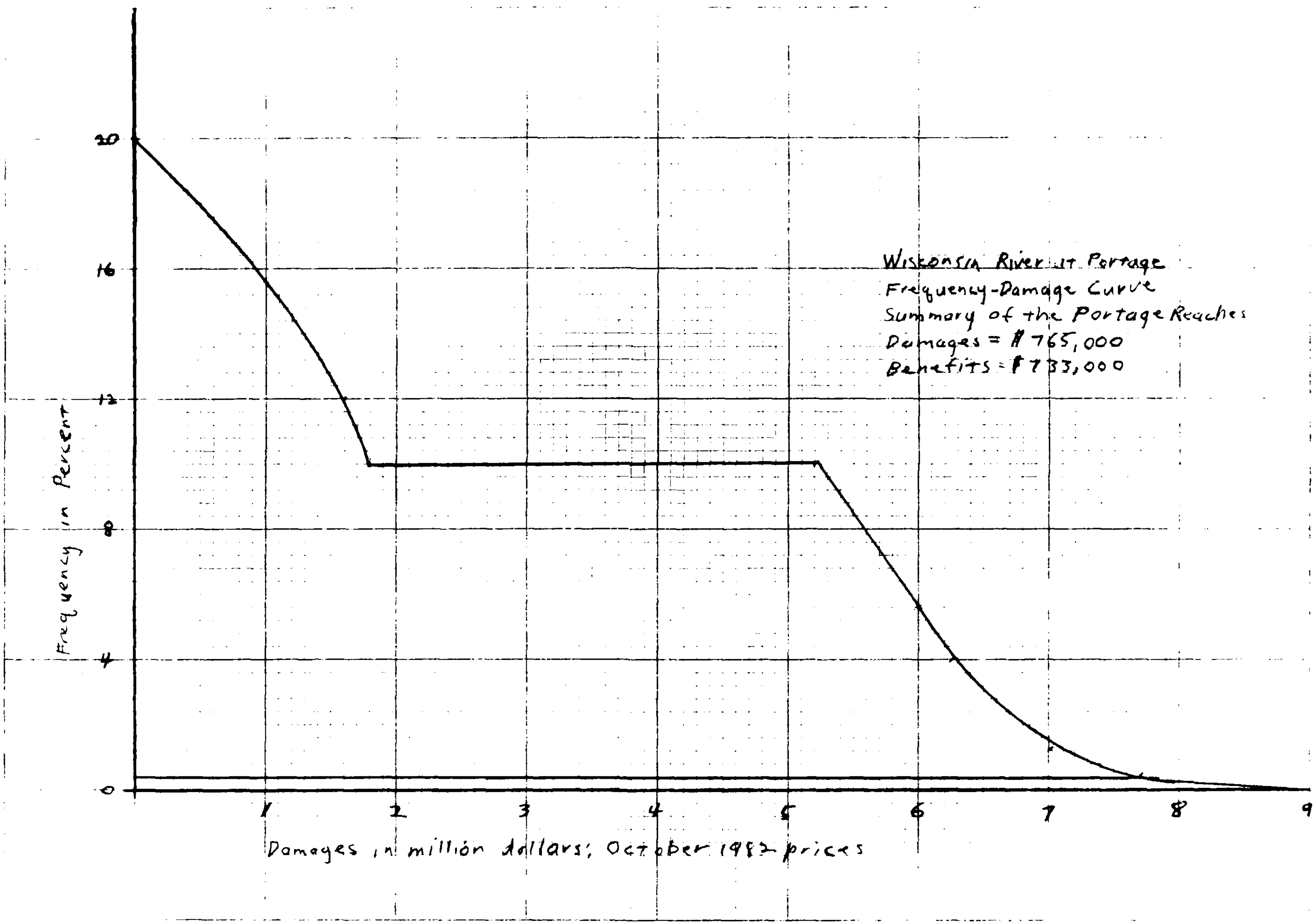

Wisconsin River at Portage
Frequency-Damage Curve
Reach 8 Commercial
Downstream of the lock
Damages = $272,000
Benefits = $260,000
Frequency in percent
0
4
8
12
16
20
1
2
3
4
5
Damages in million dollars; October 1982 prices

PLATE F-8



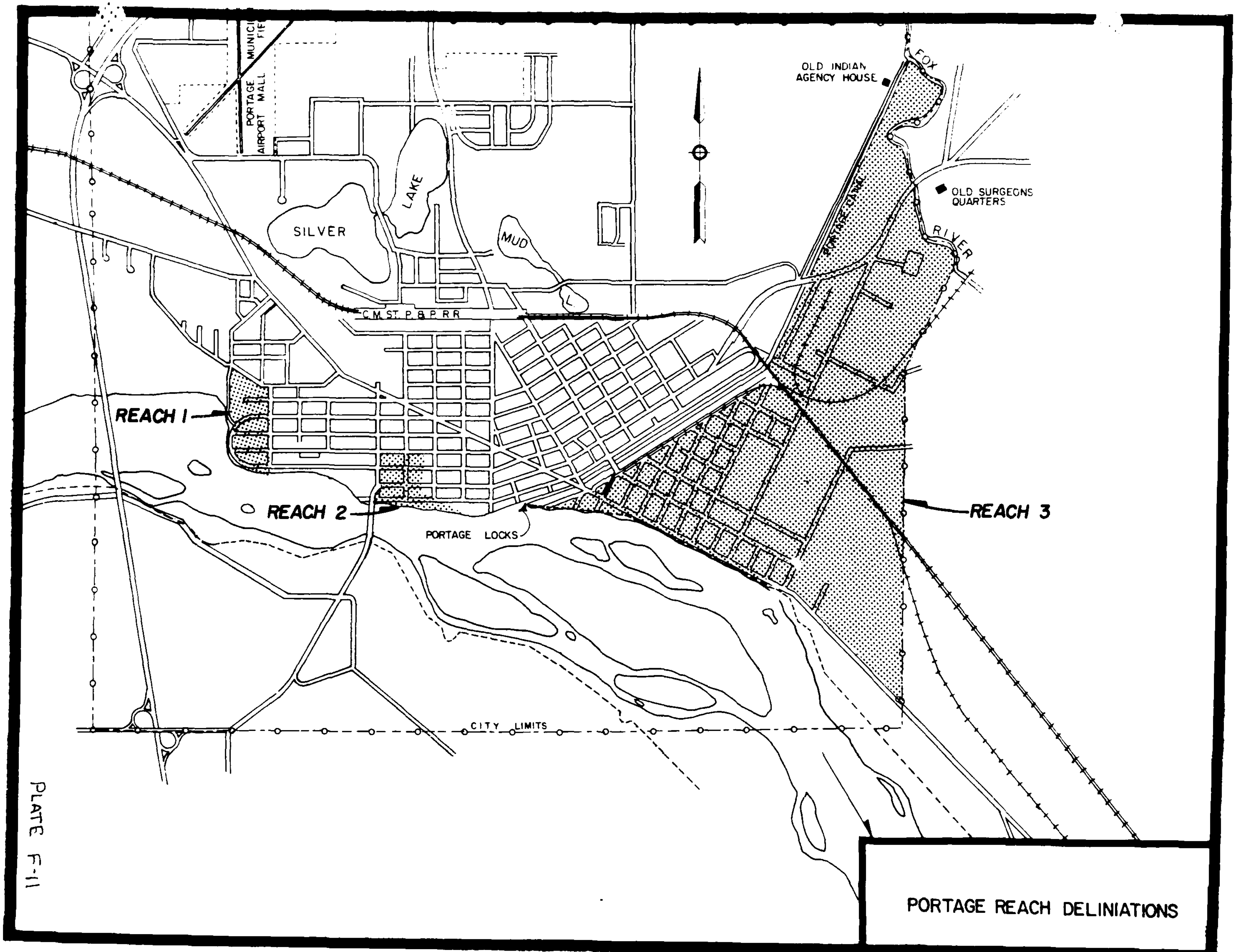
Wisconsin River at Portage
Elevation - Damage Curve
Summary of all Reaches
Damages in Million Dollars, October 1982 Prices
Flood Elevation at the Portage Lock
785
787
789
791
793
795
797
2
4
6
8
10
12
14
16
18

Plate F-9



Wisconsin River at Portage
Frequency-Damage Curve
Summary of the Portage Reaches
Damages = $765,000
Benefits = $733,000
20
16
12
8
4
0
1
2
3
4
5
6
7
8
9
Frequency in Percent
Damages in million dollars; October 1982 prices

Plate E-..



PORTAGE REACH DELINIATIONS

PLATE F-11

FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER
at
PORTAGE, WISCONSIN

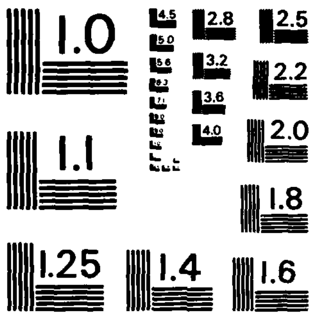
APPENDIX G

CULTURAL AND ENVIRONMENTAL RESOURCES

December 1983

AD-A148 351 FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT WISCONSIN RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 83 6/9

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX G

PART I - CULTURAL RESOURCES

TABLE OF CONTENTS

FIGURES

TABLE OF CONTENTS (cont.)

PLATE

PART II - ENVIRONMENTAL RESOURCES

PART I

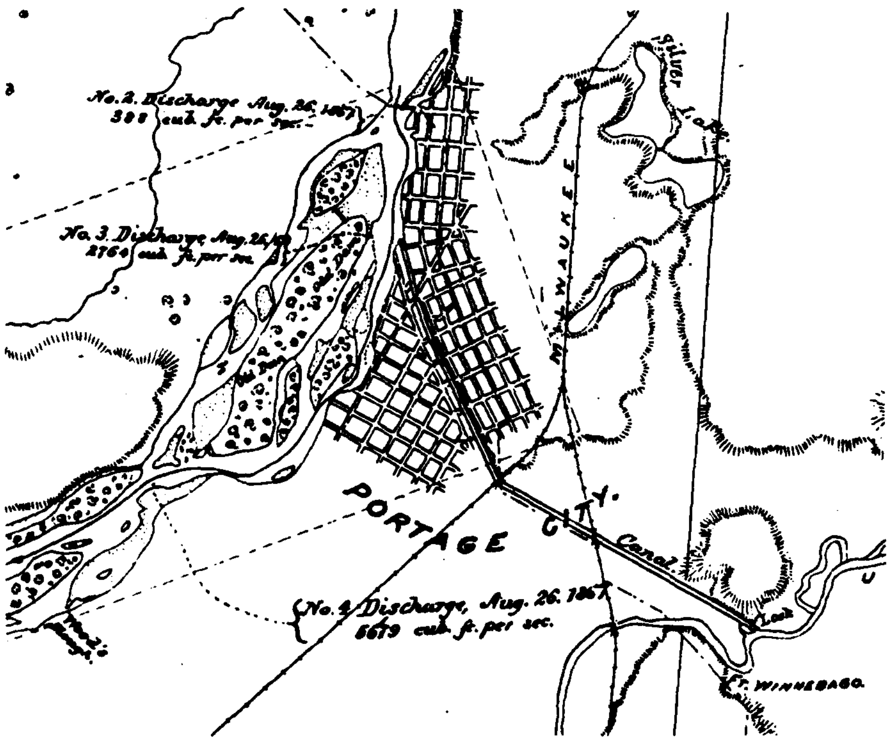
CULTURAL RESOURCES

PART I - CULTURAL RESOURCES

INTRODUCTION

"Of all the points of historic interest in Wisconsin, none stands out in bolder relief than the scant two miles of low plain that separates the Fox from the Wisconsin River at the great westward bend of the latter."

(W.A. Titus, 1919:8)



From: Report on the Transportation Route along the Wisconsin and Fox Rivers, by Gouverneur K. Warren, Annual Report of the Chief of Engineers for 1876.

The area surrounding the city of Portage, Wisconsin, has a long and colorful history. The earliest known inhabitants of the area hunted and collected food resources along the Fox and Wisconsin River . Small campsites recently located along the Wisconsin River have been dated to the Archaic Period between 6000 and 3500 B.C. (Overstreet, 1918:16). With developing river transportation, the portage between the Fox and Wisconsin Rivers became a focal point for travel between northeastern Wisconsin and the Mississippi River to the West. Indian inhabitants of the area helped the first French explorers make the portage from the Fox River to the Wisconsin River. The portage, known as Wau-o-mah by the Winnebago, was used extensively by French traders and later by the British and Americans.

During the late 1700's, the portage area began to take on the air of a permanent community (Salkin, 1980:218). In 1828, Fort Winnebago was constructed on the east side of the Fox River to protect the Fox-Wisconsin portage (McKay, 1981:27). The settlement of the city of Portage in the 1840's developed around three areas: Fort Winnebago, the Wauona Trail, and the present business district (McKay, 1981:31). Portage's early history centered around the transportation of goods, first by water routes and later with establishment of the railroad in 1857. During the late 1800's Portage began a period of industrial growth which continued into the early 1900's. McKay (1981:44) concludes her discussion on the historical context of Portage by stating that "Portage's major historical importance lies in its ability to remain the nexus of a regional transportation system through the centuries."

PREVIOUS STUDIES

ARCHEOLOGICAL STUDIES

Although a large number of archeological resources exist in the Portage area, little systematic survey work has been undertaken. Many of the early reports of archeological discovery were due to local residents and amateurs who collected antiquities and excavated local mounds.

It was not until the late 1950's that any systematic survey was undertaken by professional archeologists. In 1959 an archeological survey was conducted for the Interstate 94 right-of-way by Robert Salzer and James Porter (1959). In 1964 Paul Koeppler surveyed the previously recorded Portage Mound Group.

Three years later Jay Brandon (1967) compiled a report on his preliminary test excavation at Fort Winnebago. The purpose of Brandon's excavation was to relocate the Fort Winnebago commissary building. Peters and Overstreet (1972) conducted a survey of the proposed Columbia Power Plant site in Dekorra and Pacific Townships. In 1978 James Stolman of the University of Wisconsin-Madison surveyed a boat launch basin and connecting channel on Swan Lake.

Two surveys were conducted in 1979, one by T. Douglas Price (1979) and the other by Philip Salkin (1979). Price surveyed a sewage treatment plant and interceptor route while Salkin surveyed three proposed wastewater treatment plant sites.

In August 1980, Philip Salkin of the University of Wisconsin at Whitewater prepared a literature search on the cultural resources of the Portage area. This work was done under contract with the St. Paul District as a result of the flood control project at Portage. In 1981,

under contract with the St. Paul District, David Overstreet and Allen Van Dyke completed an archeological reconnaissance survey of portions of the Lewiston and Portage levees (1981).

Salkin (1980) identified 131 archeological sites in the Portage area. These sites had both prehistoric and historic American Indian components. He also compiled a list of 137 structures of historical and architectural interest. Salkin concluded that, even though there has not been a strong professional interest in the Portage area in the past, there appears to be a great potential for recovery of prehistoric and early historic materials.

The Overstreet and Van Dyke survey (1981) focused on a relatively small area along the existing Lewiston and Portage levees. Ten locations were selected for survey at levee terminuses. In all, only 42.6 acres were surveyed, yet cultural material was recovered at six of the ten locations examined. As a result of this work, four previously unrecorded archeological sites were located, one archeological find was reported, and an area was recorded for which an archeological deposit is virtually certain.

HISTORIC STUDIES

In addition to the histories of Columbia County (Butterfield, 1880; Jones, 1914) and the large volume of primary sources housed at the State Historical Society of Wisconsin, a number of recent cultural resources surveys have been conducted in the Portage area for several different State and Federal agencies. The earliest study, "Historic Portage: A Study of the Feasibility and Implementation of Developing the Historic and Related Resources of the Portage Area as a Part of the South Central Wisconsin Region," was undertaken for the Governor's Portage Canal Implementation Committee by Frank and Stein Associates of Lansing, Michigan. Completed in 1969, this report concludes that it is economically feasible to restore the Portage Canal and Fort Winnebago and

presents a plan by which this could be accomplished. Although little historical research or analysis accompanies the report, it is useful as a recreational planning tool.

In 1974, the State Historical Society of Wisconsin conducted a standing structure survey of the city of Portage. The survey was very preliminary, and it did not include evaluation of historical or architectural significance.

The Environmental Protection Agency contracted with George Bartnick in 1979 to survey the location of a new sewage treatment plant in Portage for historical and architectural resources. Completed in 1979, Bartnick's report is historically limited to a pre-1860 time frame.

The literature search conducted by Salkin (1980) included discussions on the early history of Portage. Salkin focused on the ethnohistory and early history of Portage and limited his discussions to pre-1860 events.

Joyce McKay (1981) conducted a historical and standing structure study of the Portage flood control project under contract with the St. Paul District. This study focused on collecting data in Ward 1 of the city. A total of 218 structures which date prior to 1930 were studied through a pedestrian survey of Ward 1. McKay concluded that much of Ward 1 bears little resemblance to any period in the past, although some small areas retain their past density and architectural style.

ARCHEOLOGICAL OVERVIEW

The following archeological overview must, of necessity, be taken from areas and counties outside the Portage area. No archeological sites within the study area have received recent archeological attention in the form of formal excavation. Most of the sites in the vicinity of Portage were reported to Charles E. Brown of the State Historical Society of Wisconsin in the 1920's and 1930's. Information from these sites, and

those reported since then, is derived mainly from collections made on the surface of these sites. The overview is divided into four major periods of prehistory: Paleo-Indian, Archaic, Woodland, and Oneota.

PALEO-INDIAN

At the present time archeologists do not know the exact date that man entered the North American continent; however, the most widely accepted date is 12000 B.C. At that time it is likely that ice from the Cary Ice advance covered the project area. The area would not have been available for habitation until this glacial ice began to wane.

Fluted projectile points, such as the Clovis and Folsum types, are diagnostic of the early Paleo-Indian period (ca. 11500-8000 B.C.). Although more than 100 fluted points have been found in Wisconsin, none have been reported from Columbia County (Stoltman and Workman, 1969; Salkin, 1973). Salkin (1980:172) points out that this absence of fluted points in the county is probably not related to a lack of occupation. Rather, no examples of fluted points have been found, since Columbia County is one of the few counties in southern Wisconsin which are devoid of this material.

Unfluted lanceolate or Plano points are diagnostic of the late Paleo-Indian period (ca. 8000-4500 B.C.) Projectile point styles of this period include the Plainview, Agate Basin, Browns Valley, Eden, and Scottsbluff types. Salkin (1980:174) notes that the densest distribution of these points is in eastern Wisconsin where they are associated with the fossil beaches of Lake Michigan. Again, points of this style have been found in surrounding counties, but none have yet been found in Columbia County.

Paleo-Indian lifeways have been difficult to define because of the paucity of material remains. Sites are typically surface scatters which have been located by amateurs. Interpretations are usually associated

with the Big Game Hunting Tradition of western Paleo-Indian groups (Overstreet, 1982:34). Groups were small, nomadic bands of hunters which used Pleistocene megafauna such as mammoth and mastadon and, later, smaller species which as deer, elk, caribou and bison.

ARCHAIC

The Archaic Period in eastern North America lasted from 9000 B.C. to 1000 B.C. During this period, many changes were taking place in the climate, fauna, and flora of the area. Of necessity, man's adaptive strategies for using his environment were also in a state of flux.

The Early Archaic Period (ca. 9000-6000 B.C.) witnessed a growing population using a variety of larger stemmed and notched projectile points to procure both large and small mammals. Many of these Early Archaic sites, especially along the Ohio River and its tributaries, show strong ties with a riverine habitat. No Early Archaic sites have been found in Columbia County to date; however, this again is probably due to the lack of intensive survey efforts in this area.

The Middle Archaic Period (ca. 6000-3500 B.C.) is associated with the introduction of ground stone tools, copper artifacts, and intensive exploitation of freshwater mussels from riverine habitats. It is believed that the introduction of ground stone artifacts shows an increased importance placed upon the use of plant foods. The earliest sites found in the project area date to this period based upon the discovery of Raddatz side-notched projectile points (Overstreet 1981: 16). This point type was first described in the excavation of the Raddatz Rock shelter (Wittry, 1959) in adjacent Sauk County where a level containing this point type was radiocarbon dated to 3241 ± 400 B.C.

The Late Archaic Period (ca. 3500-1000 B.C.) shows a significant increase in population size based on increased density and size of sites. At the end of the Middle Archaic Period the Old Copper Tradition was developing

in northeastern Wisconsin. Data collected on this tradition support evidence from other areas of North America to show that Late Archaic peoples were developing long distance trading networks and elaborate rituals for dealing with the dead. Copper from this period came primarily from the Lake Superior basin, and it was used to fashion axes, knives, spear points, fishhooks and sometimes ornaments. These implements and ornaments have been excavated from graves in Old Copper cemeteries. At least nine reports of copper artifacts are known from the project area (Salkin, 1980:182).

WOODLAND

The Woodland Period (ca. 1000 B.C. - historic period) shows a number of significant changes over the preceding Archaic Period. During this period ceramics were introduced, corn horticulture brought about population growth and increased stability, and the construction of earthen burial mounds was widespread.

The Early Woodland Period (ca. 1000-300 B.C.) was a time of gradual transition when lifeways did not differ greatly from the Late Archaic Period. Two ceramic styles are typical of the Early Woodland; incised over cordmarked vessels (Black Sand Incised) and thick walled vessels with interior cordmarking (Marion Thick). Dane Incised is a regional nomenclature for the incised over cordmarked ceramics. Evidence of the Early Woodland Period in the Portage area is scant; however, the Murray site (CO-178), just south of Portage, yielded Dane Incised sherds (Salkin, 1980:187).

The Middle Woodland Period lasted from 300 B.C. to A.D. 400. The most conspicuous feature of the period was the development and expansion of the Hopewell culture. Hopewellian traits included a mortuary complex with elaborate grave goods, earthworks, pan pipes, platform pipes, and distinctive rocker and dentate stamped pottery. Long distance exchange networks brought valued goods such as obsidian, mica, sharks teeth,

copper, and conch shells to many of the peoples in the eastern part of the country. Recent investigations of Middle Woodland sites have demonstrated that "in spite of widespread similarities in artifact style, each regional manifestation of Hopewell is distinctive and may be better interpreted in terms of local cultural sequences" (Fitting, 1978: 45).

Salkin (1980:190) states that Middle Woodland sites in the Portage area are rare. The only three reported sites with Middle Woodland components are the Johnson site (CO-109) in Caledonia Township, the Murray site (CO-178) in Pacific Township, and an unnamed site (CO-220) in Caledonia Township. Salkin (1980:190) believes that much of the information on Middle Woodland may be found in the numerous conical and oval mounds in the study area.

Late Woodland sites in Wisconsin date between A.D. 400 and historic times. During this time period, the Effigy Mound Tradition developed in Wisconsin, southwestern Minnesota, northeastern Iowa, and northwestern Illinois. The predominant feature of this tradition was the construction of burial mounds in geometric and animal effigy forms. Ceramics were cordmarked and cord impressed forms. The economy of the Effigy Mound people was one of hunting and gathering, and they relied in only a limited way on plant domesticates.

Within the Portage area, over 193 mounds have been recorded in the State site files (Salkin, 1980:193). Only seven of these mounds can be definitely assigned to the Effigy Mound Tradition. Salkin (1980:195) believes that many of the camps and villages within the project area may relate to this tradition based on association with certain lithic and ceramic types (CO-71, CO-177, CO-178, CO-179 and CO-156).

ONEOTA

By approximately A.D. 800 the Oneota culture was appearing in southern Wisconsin as a neighbor of other Late Woodland cultures. Oneota, influenced by the large Mississippian culture centers to the south, was distinctly different from the other Late Woodland cultures. These people lived in larger, more permanent settlements which resulted from their corn horticulture subsistence pattern. Oneota ceramic vessels used shell tempering rather than grit, and decoration was trailed and incised motifs on vessel shoulders and rims.

Oneota sites in the project area are rare, although surrounding counties have evidence of Oneota occupation (Salkin, 1980:198). Based upon the environmental locations of Oneota sites and the existence of similar environments in Columbia County, Salkin (1980:198) feels that Oneota sites probably exist in the county but have yet to be located. Two sites in the project area have yielded shell tempered ceramics: the Murray site (CO-178) in Pacific Township and the Basin Lake Village site in Dekorra Township (Salkin, 1980:199).

HISTORICAL OVERVIEW

British immigrants were still struggling to secure their settlements in New England and the Chesapeake Bay when the potential of the Fox-Wisconsin waterway was being realized by their adversaries, the French. Having access to the western Great Lakes through a military and trading alliance with the Huron Indians of eastern Canada, the French probed deep into the interior by the 1630's. Spurred by hopes of discovering a sea route to the Far East and new sources of furs, the Frenchman Jean Nicolet canoed down the Fox River into east central Wisconsin in 1635. Although there is no written account, he may have reached the portage at this early date. By the second half of the 17th century the French were forced to become more serious in their efforts to explore the interior (Trigger, 1976).

In 1649 and 1650, the Iroquois destroyed the Huron in a series of battles; as a result, the French had to seek new political and economic partners farther west. On June 14, 1673, Father Jacques Marquette and explorer-trader Louis Joliet crossed the portage between the Fox and Wisconsin Rivers, leaving the first written account of the narrow crossing. They were soon followed by other missionaries, explorers, and traders such as Father Louis Hennepin, in 1680, and Robert Chevalier sieur de La Salle in 1683 (McKay, 1981:21-22).

The importance of the Fox-Wisconsin waterway to the French was magnified in the 1680's when the British began to establish posts on Hudson Bay. Most of the rivers of central Canada flow northward to the bay and, without direct and inexpensive access to the Indians of the interior, the French would have had serious problems establishing and maintaining alliances. Though they contested the British posts on the bay, they were forced to concede control by the Treaty of Utrecht in 1713. Now pinched between the British colonies on the American east coast and Hudson Bay, the French focused on securing and developing their transportation system along the Great Lakes and the Mississippi River (Ray, 1974).

Despite the efforts of the French to strengthen their positions in the Northwest, as fortified posts at Green Bay (1717) and Prairie du Chien (ca. 1685) attest, they lost their claim to Canada by the Treaty of Utrecht (which ended the Seven Year War in Europe) in 1763. But the Fox-Wisconsin waterway and the portage continued to play an integral part in the development of British and American interests.

The crossing of the portage became such a regular event that Laurent Barth (one of the many Frenchmen who stayed after France withdrew from Canada) established a carrying service in 1792 or 1793 with permission from the Winnebago. Within 6 years, a competing service was started by Jean Le Cuyer who, shortly after the turn of the century, gained control of Barth's portion of the business (McKay, 1981:25). The primary method

of transportation across the portage at this time was by oxcart. And in 1817 the new owner of the portaging service, Frances LeRoy, was charging $2 per boat and 50 cents per 100 pounds of goods for transport over the portage.

Although the Americans won their independence from the British in the Revolution, the Jay Treaty of 1786 provided that the British could remain in the Northwest Territory. As the French had once tried to strengthen their position in this region against the British, the British now did so against the Americans, anticipating the coming second war with them. Despite their Indian alliances in the Old Northwest, the British lost the War of 1812 and were ousted from the region shortly after the Treaty of Ghent in 1816.

The Americans became the third nation (recognizing that various Indian tribes were the first inhabitants of the region) to occupy the Old Northwest and continued to use the Fox-Wisconsin waterway as the major transportation route for commercial and military expansion.

The fur trade remained the primary economic pursuit of Americans in the Wisconsin area well into the 1830's, though its profitability was declining. The primary military concern became the Indians of the area. The Old Northwest was in a period of transition in which efficient transportation systems were becoming of paramount importance to regional development.

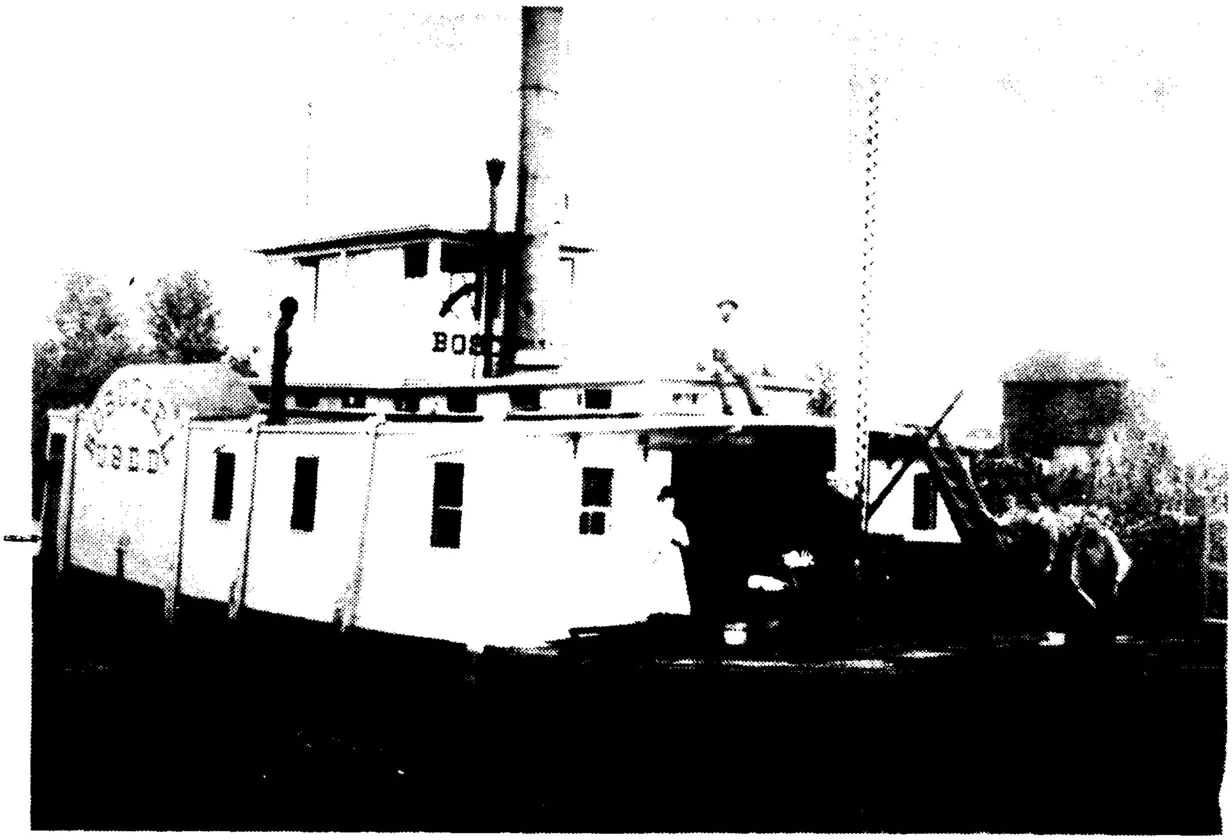
The United States established forts at Green Bay (Fort Howard) in 1816. In 1828 Major David Twiggs and Lieutenant Jefferson Davis were sent to build Fort Winnebago at the portage. This fort was to protect the fur trade and settlers who were engendering Indian hostility as they came in increasing numbers to the region.

Between 1835 and 1838 soldiers from the fort participated in the construction of a military road from Fort Howard through Fort Winnebago to Fort Crawford, thus enhancing the Fox-Wisconsin waterway as a major transportation route (McKay, 1981:27-29).

As the fur trade declined, new staple products lured immigrants from the East coast and abroad and stimulated strong incentives for improved transportation systems. During the period 1815-1860, a significant redirection of economic flow occurred. By the beginning of the Civil War, East-South orientation had shifted to East-West (North, 1966:61-65). Wheat replaced furs as the principal commodity around which western development would occur, but this development was dependent upon efficient transportation methods and routes.

The opening of the Erie Canal in 1825 led the way for the canal boom of the 1830's in which the connection of the Mississippi River drainage system with the Great Lakes was a primary objective (North, 1966:142-143). The short 1.3 miles between the north flowing Fox River and the south flowing Wisconsin River was an obvious location for a canal, and in 1835 the Portage Canal Company made the initial efforts to build one. The project, however, became too expensive and had to be abandoned. One year later the Federal Government commissioned Thomas Jefferson Cram to survey the waterway and determine its manageability, but nothing was attempted again until 1848. The Federal Government provided a land grant to support the construction of a canal and locks, and construction began again in 1849 with supervision of the State Board of Public Works. Rather than following the Wauona Trail, as in the first attempt, the new canal followed the 2-mile-long alignment of the existing canal. But funding was short again and, although the canal was finished in 1851, it was not large enough to allow steamer passage. It was destroyed by a flood months after it was completed (McKay, 1981:35).

The project languished until the 1870's when the Corps of Engineers took it over and completed it in 1876. The following photograph shows the first boat to cross through the Portage Canal. Although there was extensive steamer and small craft traffic for the next 30 years, the canal had been completed too late; the La Crosse and Milwaukee Railroad reached Portage from Milwaukee in 1857 and was extended to La Crosse in 1858 (McKay, 1981:38) outmoding other forms of transportation.



The BOSCOBEL, first boat through the Portage Canal, June 30, 1876. Taken from the original in possession of the Portage Canal Society, Inc.

The canal continued to present problems, and both the Fox and Wisconsin Rivers proved too hard to maintain in navigable condition for anything but canoes and small boats (Salkin, 1980:244-245). In 1892 the Wisconsin Lock was partially destroyed by a flood and had to be rebuilt only to be

damaged again in 1926. Between 1926 and 1928 the Corps replaced the wood lock structure with concrete and added iron gates. By this time traffic through the canal was minimal. In 1951, the Corps converted the Fox River Lock into a dam and closed the upper part of the Fox River to commercial traffic. Since that time the canal has steadily deteriorated.

Once connected with the East by rail, Wisconsin developed into the Nation's leading grain producing State by 1860 (McKay, 1981:36), and the opportunities offered by cheap land and a strong demand for wheat led to a rapid increase in Wisconsin's population. While only 31,000 Americans lived in Wisconsin in 1840, the population had risen 20 years later to over 776,000.

In addition to producing wheat, Wisconsin harvested large quantities of timber between the 1830's and 1880's. After the 1880's both staples declined in importance to the Wisconsin economy, and dairy goods emerged as the new staple products. Associated with all of the above products were service and processing facilities, many of which were located in the First Ward (McKay, 1981:35-40 and 42).

Like many localities in the North and West during the Industrial Revolution of the late 19th century, Portage began to develop industries directed at a national market. One example, the Portage Hosiery Company, founded in 1878, produced woolen goods for many of the northern States. With the rising and falling of various staples, Portage continued to thrive up to the Great Depression, serving as a terminal point for the railroad transportation system through Wisconsin (McKay, 1981:41-43). Thus, for over 300 years, Portage functioned as a commercial entrepot, participating in almost every stage of American development.

EXISTING CONDITIONS

In 1980, Philip Salkin, in a preliminary investigation of the cultural resources of the Portage area, documented the existence of more than 300

prehistoric and historic properties along the Wisconsin River in Lewiston, Fort Winnebago, Pacific, Caledonia, and Dekorra Townships.

In all, 137 archeological sites are reported within the townships surrounding Portage. Of these sites, 131 were reported by Salkin (1980), four were reported by Overstreet (1981), and two were reported by Berwick. The majority of the sites are prehistoric sites. Seven archeological sites reported have historic components. Since much of the data reported by Salkin (1980) was based upon a literature search and records review, it is difficult to determine how many of the reported sites are still extant. In all probability, many of these sites have been destroyed by construction and agricultural activities which have taken place since the 1920's and 1930's when the sites were originally reported. However, many others may exist which have yet to be documented.

A total of 386 historic or standing structure sites exist in the project area. The State Historical Society recorded 163 of these in August 1974. Most of these were in the vicinity of downtown Portage in Wards 2, 3, 4, 5, 6, and 7. Salkin (1980: 286-7) reported 13 structures outside of Portage in Caledonia (6), Pacific (1), Lewiston (2), and Dekorra (4) Townships and one additional structure in Ward 1. McKay (1981) identified 209 structures in Ward 1 of Portage. Unlike the archeological sites, the existence of these standing structures is not questioned; the majority of these 386 structures are businesses or residences currently being occupied.

NATIONAL REGISTER PROPERTIES

Seven properties listed on the National Register of Historic Places are located within the Portage flood control project study area (see the plate at the end of Part I of this appendix). Six of these are located in Columbia County and one is located in Sauk County at the upstream end of the study area. These properties are discussed briefly below. For

properties which appear to be adjacent to or affected by the Portage flood control project, the National Register nominations for each property are provided at the end of this section.

COLUMBIA COUNTY

Fort Winnebago Site

This site, occupied from 1828 to 1845, is located northeast of Portage along State Highway 33 and to the east of the Fox River. A historical marker and wayside now indicate the location of the old fort. This site was placed on the National Register in May 1979 as a resource significant to the history of the State.

Fort Winnebago Surgeon's Quarters

This hand-hewn log structure was originally built as a fur trader's home sometime between 1818 and 1828. It was also used as a settler's store before its conversion in 1834 to Fort Winnebago's Surgeon's Quarters (Anderson, 1970). In the early 1950's the structure was restored and today it is owned by the Daughters of the American Revolution who have it open to the public. This property was placed on the National Register in October 1970 as a historic resource significant to the State.

Fox-Wisconsin Portage Site

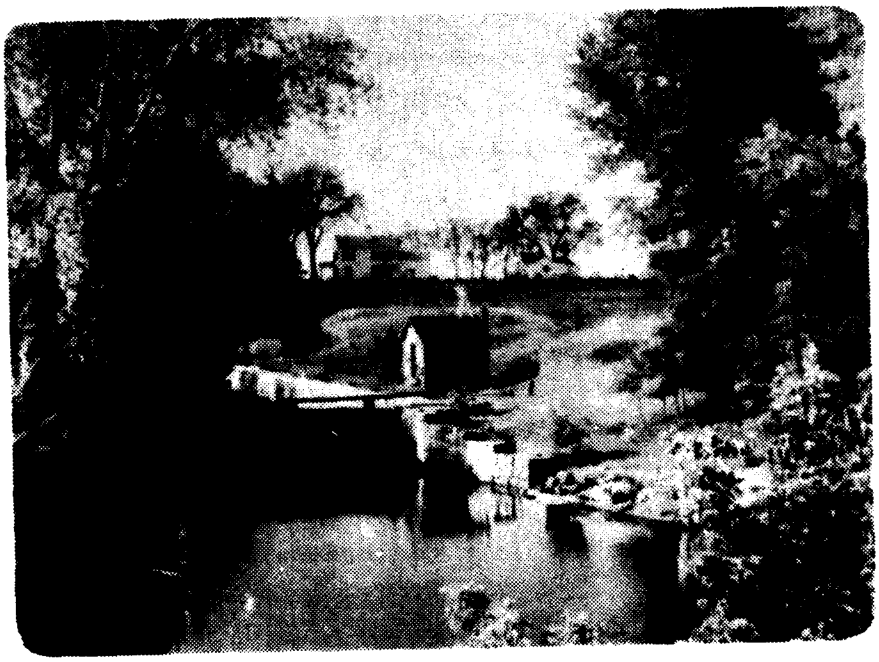
Also known as the Wauona or Portage Trail, this property was placed on the National Register in March 1973. The site is a significant feature of the State's history. For more detailed information on the Wauona Trail, see the National Register nomination form at the end of this section.

Zona Gale House

The house of Zona Gale, Pulitzer prize winning novelist of the early 1900's, was placed on the National Register in October 1980 as a nationally significant site. For more detailed information, see the National Register nomination form at the end of this section.

Old Indian Agency House

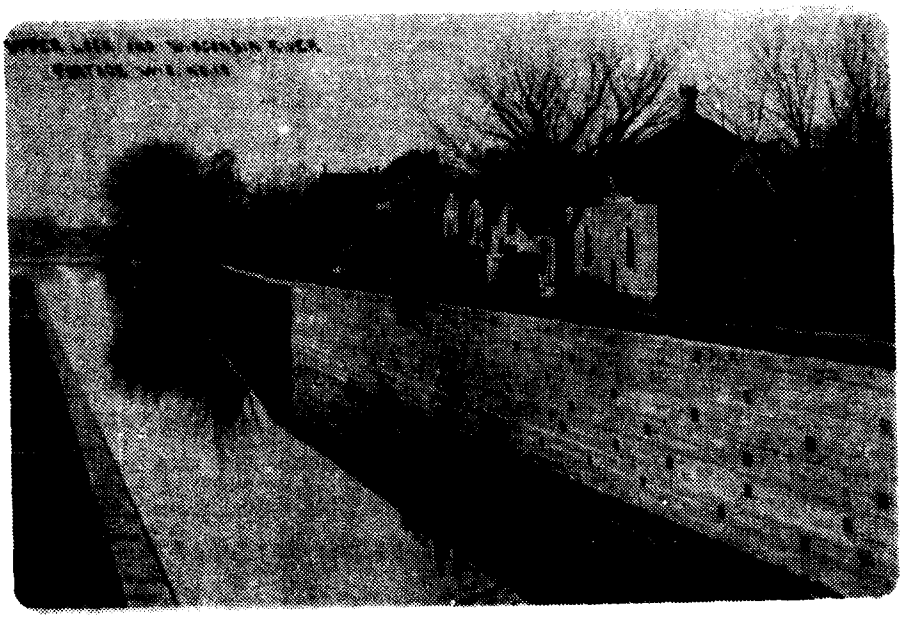
The Agency house (shown on the following photograph) was built in 1832 for John H. Kinzie, Indian Agent. The house is significant as one of the oldest and finest surviving frame houses in Wisconsin (Anderson, 1971). The style is Federal but shows a New England Colonial influence. The structure was restored in the early 1930's by the National Society of Colonial Dames and is now a museum open to the public. In February 1972 this property was placed on the National Register of Historic Places.



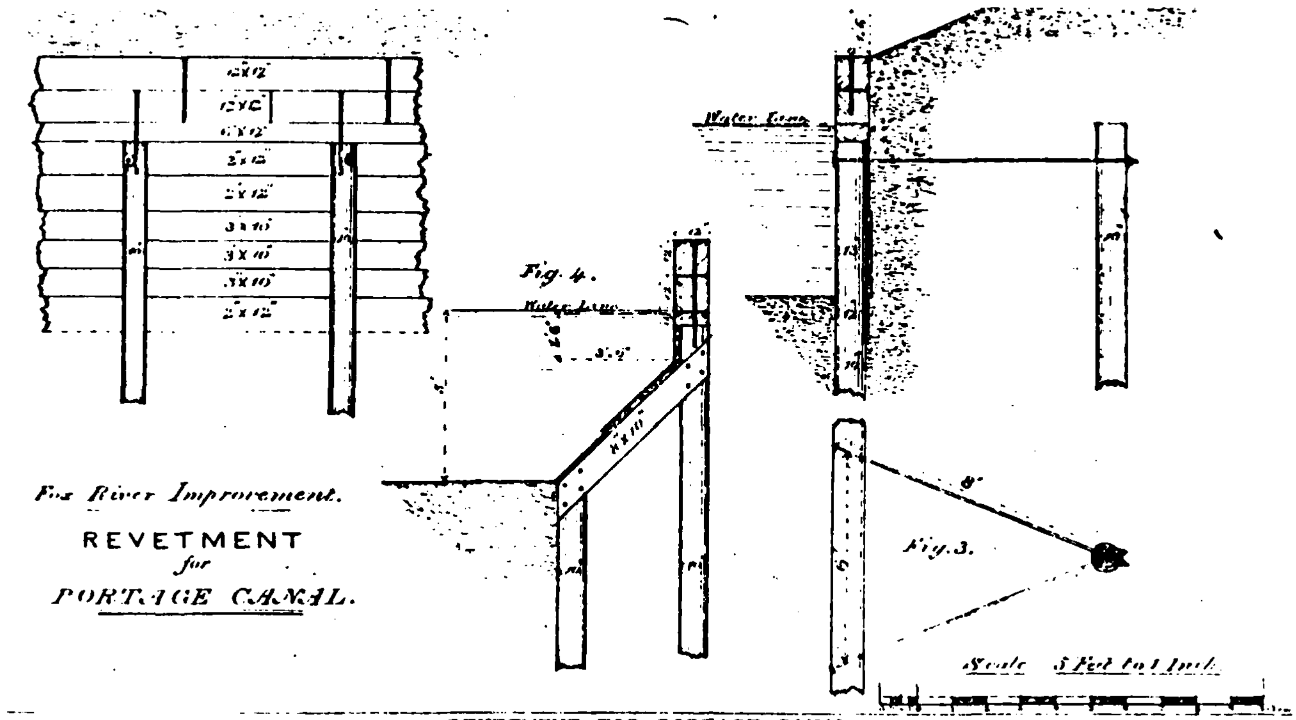
INDIAN AGENCY HOUSE

Portage Canal

The Portage Canal is a 2.12-mile-long canal on which construction first began in 1835. It was not until 1856 that the canal was sufficiently completed to allow for passage of vessels, and it was another 20 years before the canal was fully operational after being completed by the Federal Government. This site was placed on the National Register in August 1977. For more detailed information about the Portage Canal, see the National Register form at the end of this section. The following photograph and sketch show views of the canal.



PORTAGE CANAL LOCK



REVETMENT FOR PORTAGE CANAL

SAUK COUNTY

Aldo Leopold Shack

In 1935 a converted chicken coop became the weekend refuge of Aldo Leopold, the father of the American Environmental Conservation movement. This shack overlooking the Wisconsin River provided the setting for his book entitled A Sand County Almanac in which he set down his ideas about a "Land ethic". This property, placed on the National Register in July 1978, is one of national significance.

RECREATIONAL DEVELOPMENT POTENTIAL

The Portage Canal and its Wisconsin River Lock offer unique and significant recreational opportunities. The potential exists for reopening the canal for recreational navigation. However, this would require rehabilitating the Wisconsin River Lock, constructing a new lock at the Fox River end, modifying a number of bridges, and possibly dredging the canal. This would be an expensive effort and, therefore, the reopening of the canal seems remote.

The Wisconsin River lock is the most dramatic structure of the canal. The canal itself does not "tell the story" the way the lock does. Unfortunately, there is not good public accessibility, especially parking, at the lock to allow for extensive recreational development.

The Fox River end of the canal offers the best potential for developing opportunities based on the canal, Fort Winnebago, the Surgeon's Quarters, and the Indian Agency House. Considerable land is available for the development of facilities, such as picnic and camping areas.

Within the scope of this study, the Corps is restricted to lands required for the flood control project. Under the recommended plan, only the Wisconsin River Lock is on project lands. An interpretive/ information display is being proposed for that location. The Corps could not participate in any other recreation developments associated with the Portage Canal.

FUTURE STUDIES

Future cultural resources studies will be required during the design and construction phases of the project to keep the project in compliance with Federal laws and regulations. These studies will be carried out in accordance with the Memorandum of Agreement on page G-1-46.

Although the archeological reconnaissance survey completed in 1981 did not specifically survey any portion of the recommended alternative for the Portage levee, some good information was developed concerning the potential for locating cultural resources in the Wisconsin River floodplain. Based upon a reconnaissance survey of the Lewiston levee, Overstreet (1981:22) estimates a site density of one archeological site per 7.1 acres. Overstreet (1981:22) goes on to state that "...it cannot be validly demonstrated that the site densities revealed in this reconnaissance reflect reality. The locations are clearly biased in favor of topographic situations where the floodplain is interrupted by

prominent features. The data are, however, of important concern for planning levee construction or improvements and serve to underscore the very strong probability for the coincidence of levee margins and archeological sites."

This information will be useful in undertaking archeological survey work along the specific alignment selected. Other features to be surveyed include floodwall construction, areas of interior drainage, borrow areas, berm areas adjacent to the levee, relief well, and road closures.

Further work to gather data on the historical resources of the Portage area may be more limited. The recommended alternative shows levee work to be done in areas riverward of the existing levee or in low areas where no standing structures exist. The features with the greatest potential for future historical studies are in Ward 8 where evacuation of one structure may be necessary. Other historical work may be required in interior drainage areas.

A major effort in the design stage will center on the design of the floodwall structure at the Wisconsin River Lock, the design of the new gates for the lock, and the freeboard closure to be used at the lock. This design will require close coordination with the State Historic Preservation Officer and the Advisory Council on Historic Preservation to ensure that the structural and historical integrity of the Wisconsin River Lock is maintained as discussed in the Memorandum of Agreement on page G-1-46.

REFERENCES CITED

Anderson, Donald L.

1970 "Fort Winnebago Surgeon's Quarters," National Register of Historic Places Nomination Form. On file at the Historic Preservation Office, State Historical Society of Wisconsin.

1971 "Old Indian Agency House," National Register of Historic Places Nomination Form. On file at the Historic Preservation Office, State Historical Society of Wisconsin.

Bartnick, George
1979 "A Study of Alternative Wastewater Treatment Facilities for the City of Portage, Wisconsin." Unpublished report for the Environmental Protection Agency.

Brandon, Jay
1967 "Preliminary Test Excavation at Fort Winnebago." Unpublished report on file at the State Historical Society of Wisconsin.

Butterfield, C.W.
1880 The History of Columbia County, Wisconsin. Western Historical Company, Chicago.

Fitting, James E.
1978 "Regional Cultural Development, 300 B.C. to A.D. 1000." In Handbook of North American Indians, Volume 15, Smithsonian Institution, Washington.

Frank and Stein Associates, Inc.
1968 "Historic Portage: A Study of the Feasibility and Implementation of Developing the Historic and Related Resources of the Portage Area As a Part of the South Central Wisconsin Region for the Government Portage Canal Implementation Committee." Unpublished report prepared for the State of Wisconsin.

Jones, James Edwin

1914 A History of Columbia County, Wisconsin. Lewis Publishing Company, Chicago.

Koeppler, Paul

1964 "Portage Mound Group." Wisconsin Archaeologist 45(3): 144-145.

McKay, Joyce

1981 "An Historical and Standing Structure Study of the Flood Control Project at Portage, Columbia County, Wisconsin: A Reconnaissance Survey." An unpublished report prepared for the Corps of Engineers, St. Paul District.

North, Douglass

1966 The Economic Growth of the United States, 1790 to 1860. W.W. Norton and Company, New York.

Overstreet, David F., et.al

1982 "Cultural Resources Literature Search and Records Review - Upper Mississippi River Basin." Great Lakes Archaeological Research Center, Inc. Report No. 116, Prepared for the Corps of Engineers, St. Paul District.

Overstreet, David F. and Allen P. Van Dyke

1981 "Archaeological Reconnaissance of Lewiston and Portage Levees, Portage, Wisconsin." Great Lakes Archaeological Research Center, Inc.,Report No. 108. Prepared for the Corps of Engineers, St. Paul District.

Peters, Gordon R. and David F. Overstreet

1972 "Archaeological Survey of the Columbia County Power Plant." Wisconsin Archaeologist 53(2): 62-69.

Price, T. Douglas

1979 "City of Portage Sewerage Interceptor Route and Treatment Plant." Unpublished report on file at the State Historical Society of Wisconsin.

Ray, Arthur J.

1974 Indians in the Fur Trade: Their Role as Hunters, Trappers, and Middlemen in the Lands Southwest of Hudson Bay, 1660-1870. University of Toronto Press, Toronto.

Salkin, Philip

1973 "The Paleo-Indian Tradition in Wisconsin." Unpublished paper on file with the Department of Anthropology, University of Wisconsin, Madison.

1979 "An Archaeological Survey of Three Potential Wastewater Treatment Plant Sites in Portage, Wisconsin." Unpublished report on file at the State Historical Society of Wisconsin.

1980 "A Literature and Records Search on the Cultural Resources of Portage, Wisconsin Area." Unpublished report prepared for the Corps of Engineers, St. Paul District.

Salzer, Robert and James Porter

1959 Anthropology Folder, Columbia County, Anthropology Museum, State Historical Society of Wisconsin.

Stoltman, James B.

1978 "Archaeological Survey of Boat Launch Basin and Connecting Channel Proposed for Construction on Swan Lake." Unpublished report on file at the State Historical Society of Wisconsin.

Stoltman, James B. and Karen Workman
1969 "A Preliminary Study of Wisconsin Fluted Points." Wisconsin Archaeologist 50(4):189-215.

Titus, W.A.
1919 "Historic Spots in Wisconsin." Wisconsin Magazine of History 3(2):184-188.

Trigger, Bruce G.
1976 The Children of Aataentisic: A History of the Huron People to 1660. McGill - Queen's University Press, Montreal.

Wisconsin, State Historical Society of
1974 Architectural Survey of the City of Portage, Wisconsin. Survey on file at the State Historical Society of Wisconsin.

Wittry, Warren
1959 "The Raddatz Rockshelter, SK-5, Wisconsin." Wisconsin Archaeologist 40(2):33-69.

Added to the National Register 8-26-77

-> TMA - NOM Master - Sel - Copy

Form No 10-300 (Rev 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

FOR NPS USE ONLY
RECEIVED NRHP
DATE ENTERED

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

Submitted to NPS 4-26-77

SEE INSTRUCTIONS IN *HOW TO COMPLETE NATIONAL REGISTER FORMS*
TYPE ALL ENTRIES -- COMPLETE APPLICABLE SECTIONS

1 NAME

HISTORIC Portage Canal

AND/OR COMMON

2 LOCATION

STREET & NUMBER Between Fox & Wisconsin rivers (see appended maps) __NOT FOR PUBLICATION

CITY, TOWN Portage __ VICINITY OF

CONGRESSIONAL DISTRICT 2nd

STATE Wisconsin CODE 55 COUNTY Columbia CODE 021

3 CLASSIFICATION

CATEGORY	OWNERSHIP	STATUS	PRESENT USE	
__DISTRICT	X PUBLIC	__OCCUPIED	__AGRICULTURE	__MUSEUM
__BUILDING(S)	__PRIVATE	X UNOCCUPIED	__COMMERCIAL	__PARK
X STRUCTURE	X BOTH	__WORK IN PROGRESS	__EDUCATIONAL	__PRIVATE RESIDENCE
__SITE	**PUBLIC ACQUISITION**	**ACCESSIBLE**	__ENTERTAINMENT	__RELIGIOUS
__OBJECT	__IN PROCESS	X YES: RESTRICTED	__GOVERNMENT	__SCIENTIFIC
	__BEING CONSIDERED	__YES: UNRESTRICTED	__INDUSTRIAL	__TRANSPORTATION
		__NO	__MILITARY	X OTHER None

4 OWNER OF PROPERTY

Note: Ownership of right-of-way in dispute and not fully determinable at time of nomination

NAME Wisconsin Department of Natural Resources & Multiple Private

STREET & NUMBER 4610 University Avenue

CITY, TOWN Madison __ VICINITY OF STATE Wisconsin 53705

5 LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC. Columbia County Courthouse

STREET & NUMBER 717 East Cook Street

CITY, TOWN Portage STATE Wisconsin 53901

6 REPRESENTATION IN EXISTING SURVEYS

TITLE Wisconsin Survey of Historic Buildings and Sites

DATE March 13, 1973 __FEDERAL X STATE __COUNTY __LOCAL

DEPOSITORY FOR SURVEY RECORDS State Historical Society of Wisconsin

CITY, TOWN Madison STATE Wisconsin 53706

7 DESCRIPTION

CONDITION		CHECK ONE	CHECK ONE
__EXCELLENT	__DETERIORATED	__UNALTERED	X ORIGINAL SITE
X GOOD	X RUINS	X ALTERED	__MOVED DATE ______
__FAIR	__UNEXPOSED		

DESCRIBE THE PRESENT AND ORIGINAL (IF KNOWN) PHYSICAL APPEARANCE

The Portage Canal and its right-of-way comprise some 36.07 acres. The canal, which connects the Fox and Wisconsin Rivers, is 11,200 feet long (or 2.12 miles) and its right-of-way on either side varies from 60 feet to 95 feet. The canal has both a rural and urban environment divided by the Chicago, Milwaukee, St. Paul and Pacific Railroad bridge. The northeasterly section is lined with overhanging trees and takes on a pastoral setting, while the southern part runs through the heart of the city of Portage. Both sides of the canal were built with a timber and pile revetment and it was to be 75 feet wide and 7 feet deep. Presently the water level of the canal is 783 feet M.S.L.

The northern section of the canal is crossed by one highway bridge (State Highway 33) while the southern section is crossed by two city streets, Adams and Wisconsin.

Two locks were built. The Ft. Winnebago (Fox River) and the Wisconsin River lock were originally to be 160 feet long and 35 feet wide. The Ft. Winnebago Lock lies in ruins while the other one is said to be in an "excellent state of repair." [1] The current Wisconsin Lock, "a fairly modern structure" (date unknown), has a net length of 146 feet and net width of 35.2 feet.[2]

At present there is no current in the water. The entire length of the canal could be navigated by nothing larger than a canoe except where Adams Street crosses. At this point the canal is filled, not actually bridged, and the only opening for water is a pipe imbedded in the fill.

The Wisconsin River served as the canal's main source of water supply.

1, 2
<u>Historic Portage: A Study of the Feasibility and Implementation of Developing the Historic and Related Resources of the Portage Area as a Part of the South Central Wisconsin Region</u>, Frank and Stein Associates, Incorporated, Lansing, Michigan, 1968, 8, 10.

8 SIGNIFICANCE

PERIOD	AREAS OF SIGNIFICANCE -- CHECK AND JUSTIFY BELOW			
_PREHISTORIC	_ARCHEOLOGY-PREHISTORIC	_COMMUNITY PLANNING	_LANDSCAPE ARCHITECTURE	_RELIGION
_1400-1499	_ARCHEOLOGY-HISTORIC	_CONSERVATION	_LAW	_SCIENCE
_1500-1599	_AGRICULTURE	_ECONOMICS	_LITERATURE	_SCULPTURE
_1600-1699	_ARCHITECTURE	_EDUCATION	_MILITARY	_SOCIAL/HUMANITARIAN
_1700-1799	_ART	_ENGINEERING	_MUSIC	_THEATER
X1800-1899	_COMMERCE	_EXPLORATION/SETTLEMENT	_PHILOSOPHY	X TRANSPORTATION
_1900-	_COMMUNICATIONS	_INDUSTRY	_POLITICS/GOVERNMENT	_OTHER (SPECIFY)
		_INVENTION		

SPECIFIC DATES 1835, 1851 & 1876 BUILDER/ARCHITECT Conro, Starke & Co., Milwaukee; U.S. Army Corps of Engineers

STATEMENT OF SIGNIFICANCE

The significant factor about the Portage Canal is that it was intended to be one of Wisconsin's major water routes, linking the West to the Eastern markets and population centers. Its historic importance lies in its close association with the old Portage trail, once traversed by Indians, French fur traders and British soldiers.

During Wisconsin's territorial days, influential politicians, businessmen, and land speculators like James Duane Doty, Daniel Whitney and Morgan L. Martin saw what the economic and commercial potential of a canal at Portage would mean to Wisconsin, the Portage area, and to themselves. When talk first began about building such a canal, the fur trade and the lead industry were major causes for the steady increase in Wisconsin's population.

The first attempts at building the canal came in 1835 when the newly organized Portage Canal Company financed a large work force that managed to dig a ditch deep enough to accommodate only canoes. During the next two decades, after subsequent attempts and failures by both private interests and the state government, a navigable canal was completed to the extent that, in 1856, a small steamer made the voyage from Pittsburgh to the Mississippi via the Ohio, then up the Mississippi and the Wisconsin, through the new canal, and down the Fox to Green Bay. In reality, however, the canal was never a success, and the coming of the railroad, which reached the Mississippi at Prairie du Chien by 1857, outmoded the canal as a means of transportation. In 1872 the federal government took over the canal and completed construction by June, 1876. It refused to take over water rights, however.

The federal government retained control but closed the upper reaches of the Fox River to navigation in 1951. In 1958 it turned the canal over to the Wisconsin Conservation Department (now the Department of Natural Resources). Though never a success, the Portage Canal is a visible reminder of an interesting and important chapter in Wisconsin's transportation history.

Form No 10-300a
(Rev 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

FOR NPS USE ONLY
RECEIVED
DATE ENTERED

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

CONTINUATION SHEET **ITEM NUMBER** See below **PAGE** 1

9. Historic Portage: A Study of the Feasibility and Implementation of Developing the Historic and Related Resources of the Portage Area as a Part of the South Central Wisconsin Region, Frank and Stein Associates, Inc., Lansing, Michigan, 1968.

11. Donald N. Anderson, Historian & Registrar, Historic Preservation Division
State Historical Society of Wisconsin 29 November 1976
816 State Street 608/262-0746
Madison Wisconsin 53706

9 MAJOR BIBLIOGRAPHICAL REFERENCES

Alexander, Edward P. "Canals of Wisconsin," Wisconsin Journal of Education, 78:125-128, Milwaukee, November, 1945.

Butterfield, C.W. History of Columbia County, Wisconsin, Western Historical Company, Chicago, 1880, 499-1095.

Kanetzke, Howard. "Wisconsin Canals,: The 30th Star, 8:14-16, Madison, September, 1962.

Nesbit, Robert C. Wisconsin: A History, Madison, 1973, 203.

10 GEOGRAPHICAL DATA

ACREAGE OF NOMINATED PROPERTY 36.07

UTM REFERENCES

	ZONE	EASTING	NORTHING		ZONE	EASTING	NORTHING
A	16	303476	4826025	B	16	302725	4823675
C	16	380676	4823075	D			

VERBAL BOUNDARY DESCRIPTION

Bounded roughly on the north by the Fox River, on the south by the Wisconsin River, and on the east and west, respectively, by the limits of the Portage Canal right-of-way.

LIST ALL STATES AND COUNTIES FOR PROPERTIES OVERLAPPING STATE OR COUNTY BOUNDARIES

STATE	CODE	COUNTY	CODE
STATE	CODE	COUNTY	CODE

11 FORM PREPARED BY

NAME / TITLE
Allan T. Heninger, Planning Analyst, Historic Preservation Office

ORGANIZATION
State Historical Society of Wisconsin

DATE
5/1/75

STREET & NUMBER
816 State Street

TELEPHONE
608/262-2970

CITY OR TOWN
Madison,

STATE
Wisconsin 53706

12 STATE HISTORIC PRESERVATION OFFICER CERTIFICATION

THE EVALUATED SIGNIFICANCE OF THIS PROPERTY WITHIN THE STATE IS:

NATIONAL ___ STATE X LOCAL ___

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665). I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

SHPO Signature RiAE

TITLE Acting Director, State Historical Society of Wisconsin

DATE 4/25/77

FOR NPS USE ONLY

I HEREBY CERTIFY THAT THIS PROPERTY IS INCLUDED IN THE NATIONAL REGISTER

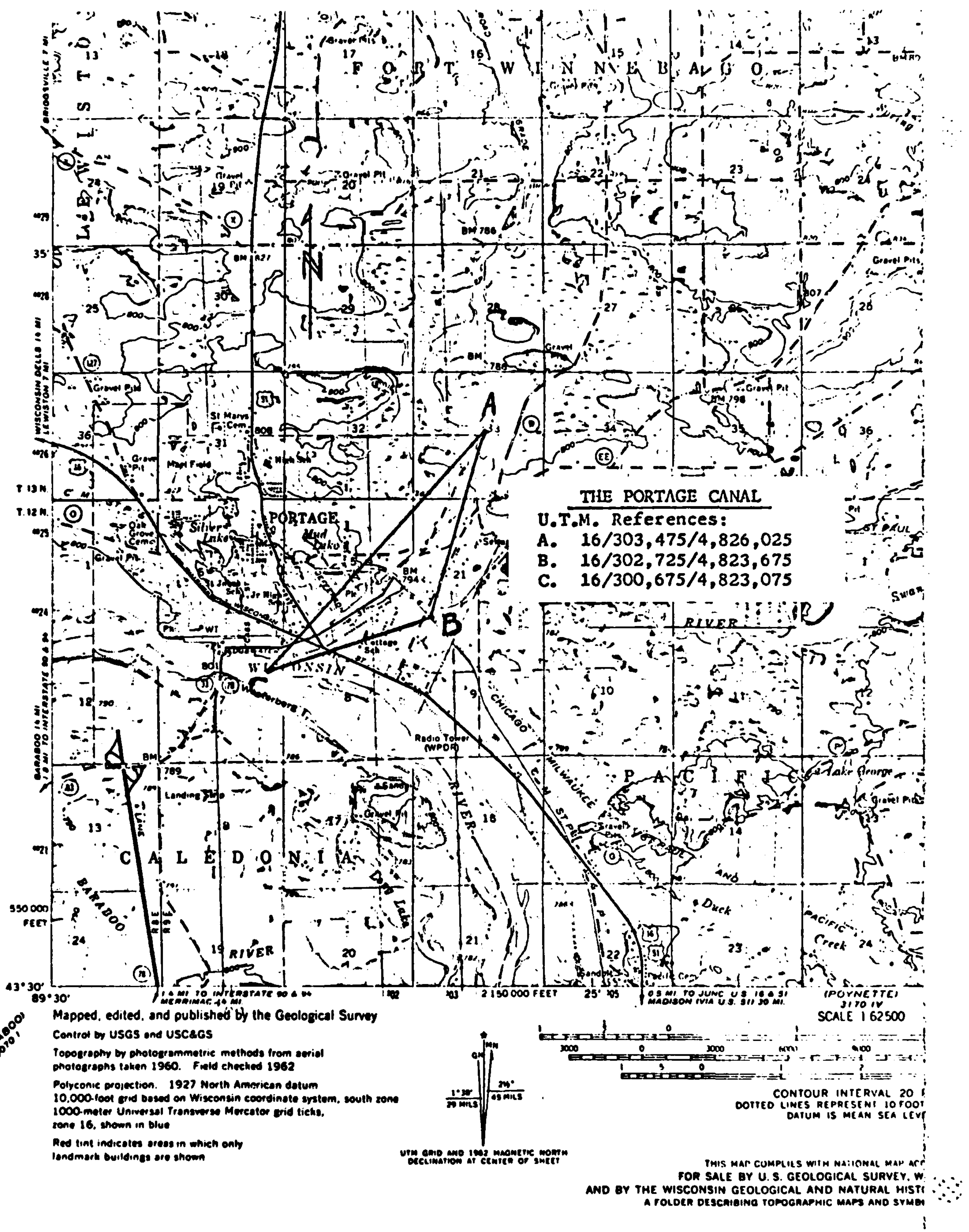
DATE

DIRECTOR, OFFICE OF ARCHEOLOGY AND HISTORIC PRESERVATION

ATTEST:

DATE

KEEPER OF THE NATIONAL REGISTER


THE PORTAGE CANAL
U.T.M. References:
A. 16/303,475/4,826,025
B. 16/302,725/4,823,675
C. 16/300,675/4,823,075
FORT WINNEBAGO
PORTAGE
CALEDONIA
PACIFIC
WISCONSIN
RIVER
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
Radio Tower (WPDR)
Landing Strip
Lake George
Duck Creek
Swan
Silver Lake
Mud Lake
BARABOO RIVER
43°30'
89°30'
550 000 FEET
2 150 000 FEET
T 13 N.
T. 12 N.
(BARABOO) 3070 I
(POYNETTE) 3170 IV
Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1960. Field checked 1962
Polyconic projection. 1927 North American datum
10,000-foot grid based on Wisconsin coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 16, shown in blue
Red tint indicates areas in which only landmark buildings are shown
UTM GRID AND 1962 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
SCALE 1 62500
CONTOUR INTERVAL 20
DOTTED LINES REPRESENT 10 FOOT
DATUM IS MEAN SEA LEV
FOR SALE BY U. S. GEOLOGICAL SURVEY
AND BY THE WISCONSIN GEOLOGICAL AND NATURAL HIST
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMB

Nat'l Reg. 3d 10/17/72 State File Copy NRHP

Added to Nat'l Register 3/14/73

Form 10-300
(July 1969)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY – NOMINATION FORM

(Type all entries – complete applicable sections)

STATE:	
Wisconsin	
COUNTY:	
Columbia	
FOR NPS USE ONLY	
ENTRY NUMBER	DATE

1. NAME

COMMON: Fox-Wisconsin Portage Site

AND/OR HISTORIC:

Congressmen to be notified:
Sen. William Proxmire
Sen. Gaylord A. Nelson
Rep. Robert W. Kastenmeier, 2nd Cong. Dist.

2. LOCATION

STREET AND NUMBER: Wauona Trail

CITY OR TOWN: Portage

STATE	CODE	COUNTY:	CODE
Wisconsin	55	Columbia	021

3. CLASSIFICATION

CATEGORY (Check One)	OWNERSHIP	STATUS	ACCESSIBLE TO THE PUBLIC
☐ District ☐ Building ☒ Site ☐ Structure ☐ Object	☒ Public ☐ Private ☐ Both; Public Acquisition: ☐ In Process ☐ Being Considered	☐ Occupied ☒ Unoccupied ☐ Preservation work in progress	Yes: ☐ Restricted ☒ Unrestricted ☐ No

PRESENT USE *(Check One or More as Appropriate)*

☐ Agricultural ☐ Government ☐ Park ☒ Transportation ☒ Comments A city street.
☐ Commercial ☐ Industrial ☐ Private Residence ☐ Other *(Specify)*
☐ Educational ☐ Military ☐ Religious
☐ Entertainment ☐ Museum ☐ Scientific

SEE INSTRUCTIONS

4. OWNER OF PROPERTY

OWNER'S NAME: City of Portage

STREET AND NUMBER:

CITY OR TOWN:	STATE:	CODE
Portage	Wisconsin	55

STATE: Wisconsin

5. LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC: City Hall

STREET AND NUMBER:

CITY OR TOWN:	STATE	CODE
Portage	Wisconsin	55

COUNTY: Columbia

6. REPRESENTATION IN EXISTING SURVEYS

TITLE OF SURVEY: Wisconsin Survey of Historic Sites and Buildings

DATE OF SURVEY: 1969-72 ☐ Federal ☒ State ☐ County ☐ Local

DEPOSITORY FOR SURVEY RECORDS: State Historical Society of Wisconsin

STREET AND NUMBER: 816 State Street

CITY OR TOWN:	STATE:	CODE
Madison	Wisconsin	55

FOR NPS USE ONLY — ENTRY NUMBER — DATE

7. DESCRIPTION

CONDITION	(Check One)					
	☐ Excellent	☒ Good	☐ Fair	☐ Deteriorated	☐ Ruins	☐ Unexposed
	(Check One)			(Check One)		
	☒ Altered	☐ Unaltered		☐ Moved	☒ Original Site	

DESCRIBE THE PRESENT AND ORIGINAL (if known) PHYSICAL APPEARANCE

As nearly as can be determined, the Fox-Wisconsin portage trail, although now covered by asphalt paving, followed the course between the Fox and Wisconsin rivers delimited by a city street named Wauona Trail and lay entirely within the limits of the street's right-of-way. It was no more than a narrow trail which was nearly a straight-line connection between the two rivers as near as was feasible to the point of their closest proximity, the limiting factor being most likely the degree of swampiness at the Fox River end. It was somewhat curved or wavy for about the first quarter of the way from the Fox, but the remaining three quarters must have been quite straight.

The site of the portage is now the asphalt-paved street, Wauona Trail, only sparsely populated and in itself possessing no particularly distinguishing features. There is some commercial and residential development, and on the west side a memorial athletic field, within the first two blocks from the Wisconsin River. Along much of the remainder, however, both sides of the narrow road contain a high growth of brush and shrubbery that seem to be left pretty much undisturbed. A red granite monument placed at the Wisconsin River end of the crossing site in 1905 by the Wau Bun (Portage) Chapter of the Daughters of the American Revolution reads, "This tablet marks the place near which Jacques Marquette and Louis Joliet entered the Wisconsin River June 14, 1673." At the Fox River end is a red granite boulder and plaque, also placed by the Wau Bun Chapter, DAR, c. 1925, and nearby across the narrow Fox is an Official Wisconsin Historical Marker to Marquette.

The portage trail is less than 1.5 miles long and is oriented in a northeast-southwest direction.

DESCRIPTION OF BOUNDARIES OF HISTORIC SITE: (see maps appended)

Bounded roughly on the north by the Fox River, on the south by the Wisconsin River, and on the east and west, respectively, by the east and west limits of Wauona Trail right-of-way.

SEE INSTRUCTIONS

8. SIGNIFICANCE

PERIOD (Check One or More as Appropriate)

- [ ] Pre-Columbian
- [ ] 15th Century
- [ ] 16th Century
- [x] 17th Century
- [x] 18th Century
- [x] 19th Century
- [ ] 20th Century

SPECIFIC DATE(S) (If Applicable and Known) June 14, 1673

AREAS OF SIGNIFICANCE (Check One or More as Appropriate)

Aboriginal
- [ ] Prehistoric
- [x] Historic
- [ ] Agriculture
- [ ] Architecture
- [ ] Art
- [x] Commerce
- [ ] Communications
- [ ] Conservation
- [ ] Education
- [ ] Engineering
- [ ] Industry
- [ ] Invention
- [ ] Landscape Architecture
- [ ] Literature
- [ ] Military
- [ ] Music
- [ ] Political
- [ ] Religion/Philosophy
- [ ] Science
- [ ] Sculpture
- [ ] Social/Humanitarian
- [ ] Theater
- [x] Transportation
- [ ] Urban Planning
- [x] Other (Specify) Exploration

SEE INSTRUCTIONS

STATEMENT OF SIGNIFICANCE

The Fox-Wisconsin portage is one of the most significant sites in the early history of Wisconsin and the old Northwest. Used by Indians long before the advent of the white man, this 1.28 mile portage has been described as being, until the middle 1800's, the only break in the water route between Lake Erie and the Gulf of Mexico.

It was over this portage on June 14, 1673, that their Miami Indian guides carried the canoes of Father Jacques Marquette and Louis Jolliet from the upper reaches of the Fox River to the lower Wisconsin "and left the travelers to go on alone" on their way to the discovery of the Mississippi, which they sighted three days later. "Now was disproved the theory that rivers ran from the Great Lakes toward the western sea, while at the same time the most convenient portage route from the basin of the Great Lakes to the waters of the Mississippi was found."[1]

For many decades thereafter the Fox-Wisconsin portage was an important route in the fur-trade, and in the 1820's John Jacob Astor complained of the Indians' habit of levying a high toll on the goods of the traders who had to cross the portage. This, among other things, led to the establishment of Fort Winnebago near the portage site in 1828 to protect it.

---

1. Kellogg, 194-195.

9. MAJOR BIBLIOGRAPHICAL REFERENCES

Clark, Satterlee, "Early Times at Fort Winnebago," Wisconsin Historical Collections, 8:309-10, Madison, 1908. (Reprint ed.)

Kellogg, Louise Phelps, The French Regime in Wisconsin and the Northwest, State Historical Society of Wisconsin, Madison, 1925, 101-195, 362.

Raney, William F., Wisconsin, a Story of Progress, Perin Press, Appleton, Wis., 1963, 18-20.

Turner, Andrew J., "The History of Fort Winnebago," Wisconsin Historical Collections, 14:65-102, Madison, 1895.

10. GEOGRAPHICAL DATA

LATITUDE AND LONGITUDE COORDINATES DEFINING A RECTANGLE LOCATING THE PROPERTY

CORNER	LATITUDE (Degrees Minutes Seconds)	LONGITUDE (Degrees Minutes Seconds)
NW	N 43° 33' 15"	W 89° 26' 07"
NE	N 43° 33' 14"	W 89° 26' 04"
SE	N 43° 32' 04"	W 89° 26' 48"
SW	N 43° 32' 05"	W 89° 26' 51"

OR

LATITUDE AND LONGITUDE COORDINATES DEFINING THE CENTER POINT OF A PROPERTY OF LESS THAN TEN ACRES

LATITUDE (Degrees Minutes Seconds)	LONGITUDE (Degrees Minutes Seconds)
° ' "	° ' "

APPROXIMATE ACREAGE OF NOMINATED PROPERTY: 12.5

LIST ALL STATES AND COUNTIES FOR PROPERTIES OVERLAPPING STATE OR COUNTY BOUNDARIES

STATE:	CODE	COUNTY	CODE
STATE:	CODE	COUNTY:	CODE
STATE:	CODE	COUNTY:	CODE
STATE:	CODE	COUNTY:	CODE

SEE INSTRUCTIONS

11. FORM PREPARED BY

NAME AND TITLE:
Donald N. Anderson, Asst. Director, Historic Sites & Markers Division

ORGANIZATION: State Historical Society of Wisconsin

DATE: June 23, 1972

STREET AND NUMBER: 816 State Street

CITY OR TOWN: Madison

STATE: Wisconsin

CODE: 55

12. STATE LIAISON OFFICER CERTIFICATION

As the designated State Liaison Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service. The recommended level of significance of this nomination is:

National ☐ State XX Local ☐

Name James Morton Smith

Title Director, State Historical Society of Wisconsin

Date OCT 5 1972

NATIONAL REGISTER VERIFICATION

I hereby certify that this property is included in the National Register.

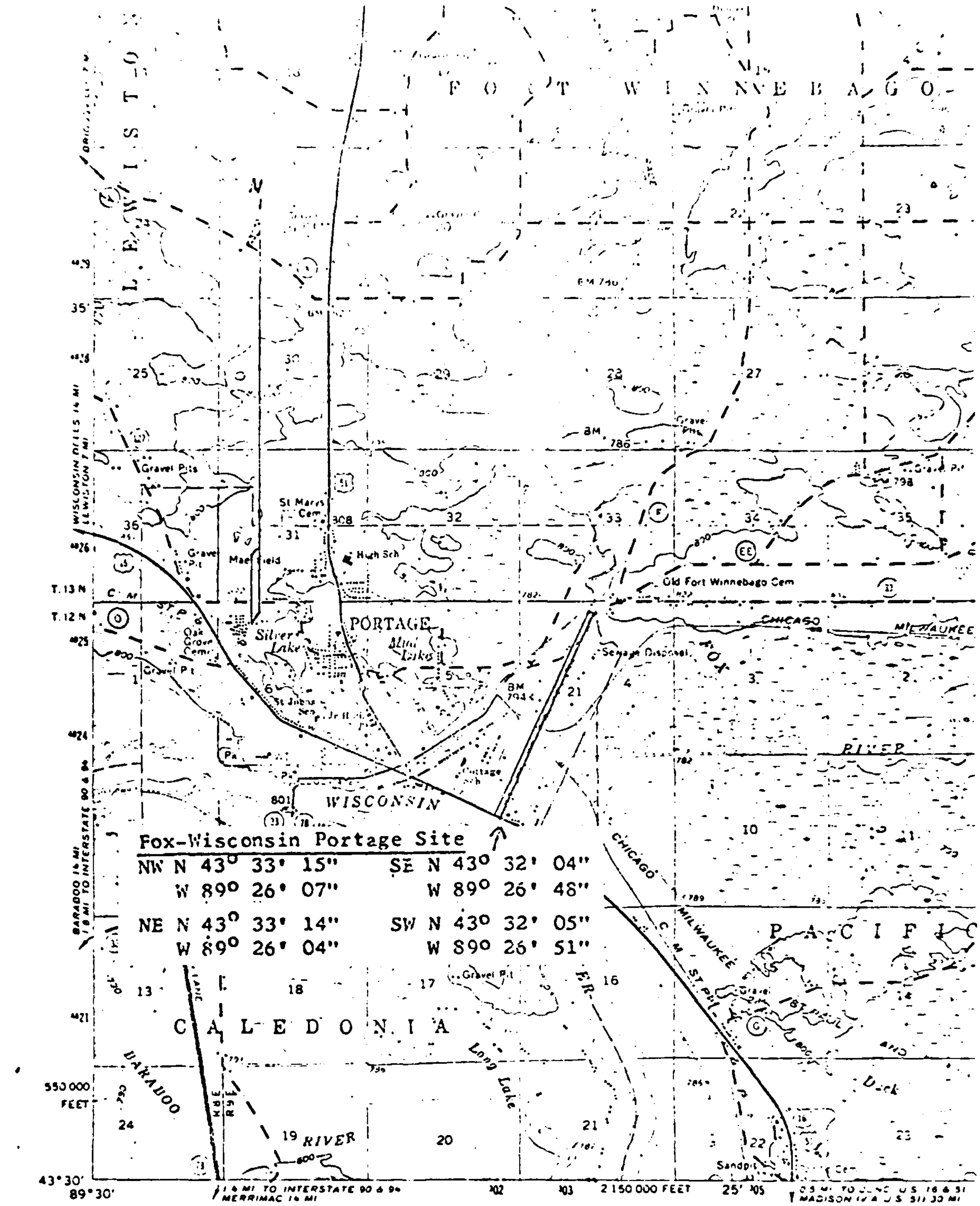
Chief, Office of Archeology and Historic Preservation

Date

ATTEST:

Keeper of The National Register

Date



Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

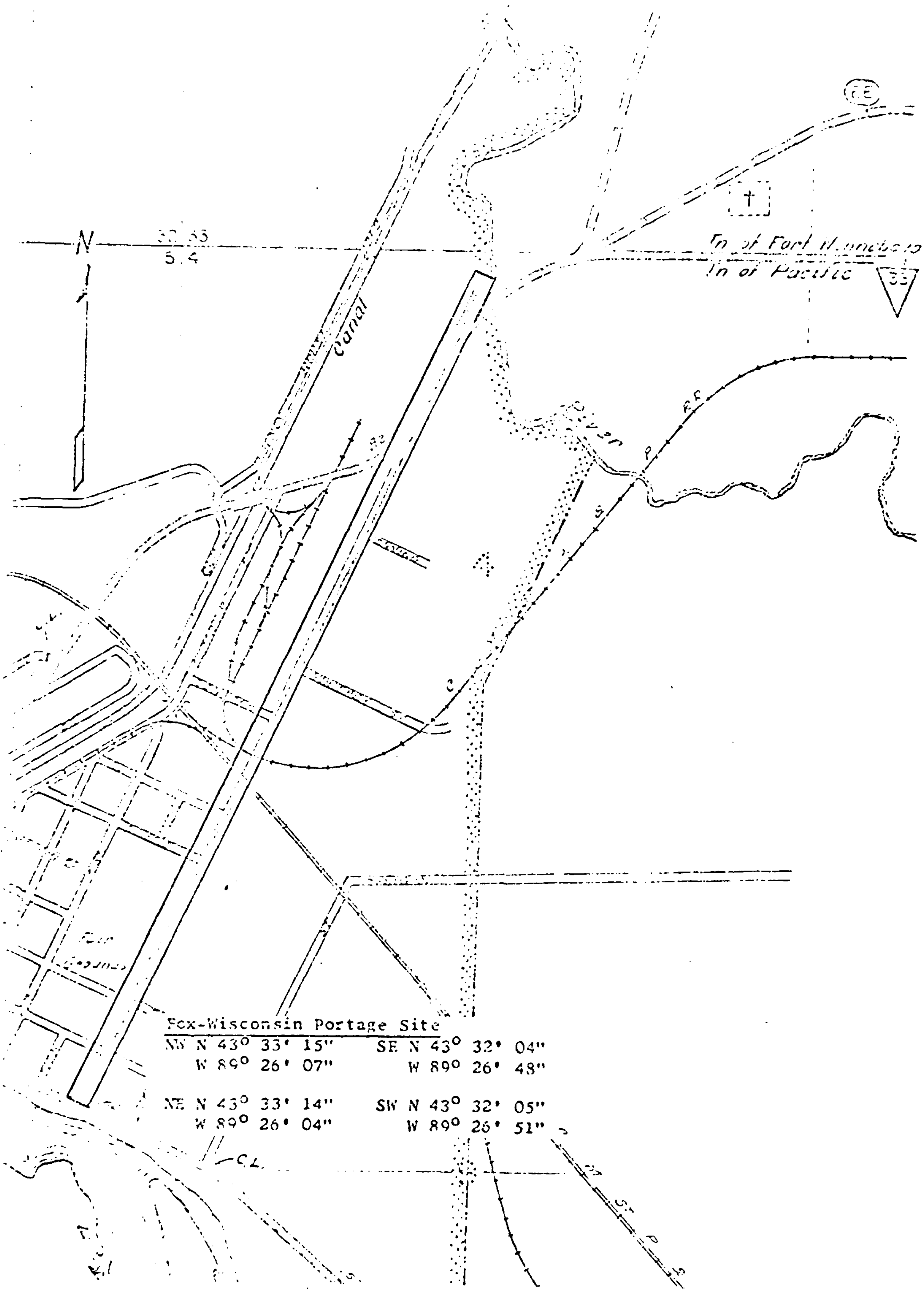
Topography by photogrammetric methods from aerial photographs taken 1960. Field checked 1962

Polyconic projection. 1927 North American datum
10,000-foot grid based on Wisconsin coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 16, shown in blue

Red tint indicates areas in which only landmark buildings are shown

UTM GRID AND 1962 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

FOR SALE BY U. S. G·
AND BY THE WISCONSIN GEOLOGICAL
A FOLDER DESCRIBING TOPOG·



Fox-Wisconsin Portage Site

NW N 43° 33' 15"
W 89° 26' 07"

SE N 43° 32' 04"
W 89° 26' 48"

NE N 43° 33' 14"
W 89° 26' 04"

SW N 43° 32' 05"
W 89° 26' 51"

Added to the National Register 10-24-80 Draft - Nomination Material to Keeper

FHR-8-300 (11-78)

United States Department of the Interior
Heritage Conservation and Recreation Service

National Register of Historic Places Inventory—Nomination Form

For HCRS use only
received
date entered 10-24-80

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections

Submitted to Interior 08-15-

1. Name

historic Gale, Zona, House

and/or common Portage Women's Civic League Clubhouse

2. Location

street & number 506 West Edgewater Street ___ not for publication

city, town Portage ___ vicinity of congressional district 2nd

state Wisconsin code 55 county Columbia code 021

3. Classification

Category	Ownership	Status	Present Use	
___ district	___ public	_x_ occupied	___ agriculture	___ museum
_x_ building(s)	_x_ private	___ unoccupied	___ commercial	___ park
___ structure	___ both	___ work in progress	___ educational	_x_ private residence
___ site	**Public Acquisition**	**Accessible**	___ entertainment	___ religious
___ object	___ in process	___ yes: restricted	___ government	___ scientific
	___ being considered	___ yes: unrestricted	___ industrial	___ transportation
		___ no	___ military	_x_ other: clubhouse

4. Owner of Property

name Portage Women's Civic League, Betty Shaw, President

street & number 506 West Edgewater Street

city, town Portage ___ vicinity of state Wisconsin 53901

5. Location of Legal Description

courthouse, registry of deeds, etc. Columbia County Courthouse

street & number 717 East Cook Street

city, town Portage state Wisconsin 53901

6. Representation in Existing Surveys

title Wisconsin Inventory of Historic Places has this property been determined elegible? ___ yes _x_ no

date 1972 ___ federal _x_ state ___ county ___ local

depository for survey records State Historical Society of Wisconsin

city, town Madison G-1-39 state Wisconsin 53706

7. Description

Condition		Check one	Check one
X excellent	___ deteriorated	X unaltered	X original site
___ good	___ ruins	___ altered	___ moved date ___
___ fair	___ unexposed		

Describe the present and original (if known) physical appearance

Set in a well-kept 1920s-30s residential area in Portage, the Zona Gale House is a two-story-plus-attic, rectangular clapboard-covered house covered by a truncated hipped roof. Centrally-located pediments project from the attic level of the house at the south (front) and north facades; on the principle facade, supporting giant-order plaster Ionic columns to each side of the center entranceway create a projecting portico raised above the rock-faced concrete block foundation, while on the south the pediment caps a two-story, three-sided bay window. One tall brick chimney rests at the west end of the roof, which is covered with asphalt seal. Fenestration mostly consists of extra-wide double-hung windows with multi-paned upper sash. Exterior decoration includes denticulation under the eaves and lining the pediments, an Ionic order doorway with cornice and mock balcony overhead on the south facade, applied giant-order Ionic pilasters at the southeast and southwest corners, and a fanlight in each pediment. A two-story porch at the western half of the rear (north) facade was covered and screened sometime after the construction of the building. This, except for minor repairs and changes such as the addition of wrought iron railings at the front steps, is the only exterior alteration. Secondary entrances located on the rear facade are approached by wood steps.

The interior of the house retains its original plan, with Zona Gale's bedroom and adjoining study preserved on the second floor to the rear. Dark oak wainscoting, floors, stairway with bench, and ceiling beams, all in excellent condition, constitute the most notable interior features. Some of the windows, particularly those in the entrance hall, contain the original diamond-paned leaded glass. Most of the furnishings of the house, including all pieces in Zona Gale's bedroom, are also original.

8. Significance

Period	Areas of Significance—Check and justify below			
___ prehistoric	___ archeology-prehistoric	___ community planning	___ landscape architecture	___ religion
___ 1400–1499	___ archeology-historic	___ conservation	___ law	___ science
___ 1500–1599	___ agriculture	___ economics	_x_ literature	___ sculpture
___ 1600–1699	_x_ architecture	___ education	___ military	___ social/ humanitarian
___ 1700–1799	___ art	___ engineering	___ music	___ theater
___ 1800–1899	___ commerce	___ exploration/settlement	___ philosophy	___ transportation
_x_ 1900–	___ communications	___ industry	___ politics/government	___ other (specify)
		___ invention		

Specific dates 1906[1] **Builder/Architect** Unknown

Statement of Significance (in one paragraph)

This house was the home of Wisconsin author Zona Gale through most of her adult life. Zona Gale's roots remained in her native Portage, although she was a prodigious traveler, and her best works, some of which were composed in the house, centered about the type of life readily found in a small midwest community. The style of the house also lends considerable architectural sophistication to the Portage area.

Literature. Zona Gale was only a minor literary figure at the time of the construction of her home in Portage. Built in 1906 as a gift to her parents, the house was also her own retreat from the pace of her literary career and life in New York City. Zona Gale carefully supervised the arrangement of the house, providing herself with a study and furnishing it with mementos of her Wisconsin childhood. She also installed a writing desk, which faced out toward the Wisconsin River.[2] During the remainder of her life, Zona Gale lived either in New York or Portage, and until her marriage in 1928 she lived in Portage in this house. She wrote portions of her works here as well, although it cannot be said with certainty which works were written at this house or any other place.[3] It is quite clear, however, that Zona Gale as a writer is best known for her works that mirror the qualities of life typified by small towns like Portage. This would include the romantic stories and novels of her Friendship Village series, as well as the more realistic play, Miss Lulu Bett, for which she won the Pulitzer Prize in 1921.[4]

During the latter part of her life, Zona Gale wrote less and became more involved in Wisconsin public affairs. Between 1923 and her death in 1938, she was a member of the University of Wisconsin Board of Regents, and involved in the selection and later dismissal of University president Glenn Frank.[5] She was also for a time a supporter of the Lafollettes and an active follower of the Progressive Party in Wisconsin. After her death, her old Portage home was given by her husband to the Portage Women's Civic League.[6]

Architecture. The Zona Gale House, imposingly situated against the Wisconsin River, is a grand NeoClassical residence of a solemnity seldom seen in the state. Friends of Miss Gale (now deceased) reported that the writer hired an architect friend from New York to produce the design. Compared with the more rambling, Colonial Revival-Style houses of similar scale built in Portage in the same era, the house is a testament to the urbanity of its architect and original owner. The formal exterior design conceals a freer, more open plan more typical of turn-of-the-century country houses. The plain oak doorframes and moldings, open stair with included bench and closed, paneled balustrade, window seats and nooks, and unadorned screened porches suggest that a more rustic living space was desired. In his biography of Gale, author and friend August Derleth suggests that Zona arranged the interior to recall her own childhood memories; the dignified "colonial" exterior she meant to be a tribute to her Eastern-born parents.[7] Thus, the house is a telling statement of both national and personal tastes and ideas.

FHR-8-300 (11-78)

United States Department of the Interior
Heritage Conservation and Recreation Service

National Register of Historic Places Inventory—Nomination Form

For HCRS use only
received
date entered

Gale, Zona, House, Portage, Wisconsin

Continuation sheet — Item number 8, 9, 11 — Page 1

8. Significance

Footnotes

1) Wisconsin State Journal, Nov. 5, 1921; Columbia County Book of Records, Vol. 116, p. :

2) August Derleth, Still Small Voice, pp. 87-90. Letters in the John Myers Olin Papers, located in the Archives of the State Historical Society of Wisconsin, discuss Zona Gale's concern to have the property properly landscaped. See her letters to Olin, April 7, May 1, 15 and August 28, 1908.

3) An excerpt from a Capital Times series on Zona Gale indicates that she wrote part of her works in Portage. See the issue for May 31, 1974. Nancy Breitsprecher, of Fort Atkinson, Wisconsin, having done extensive research on the life and works of Zona Gale, has verified that the Bridal Pond for which Gale won the O. Henry Award was written at the house in Portage. For an estimate of Zona Gale's work, and the importance of Portage, Wisconsin, to it, see the article by John O. Stark, "Wisconsin Writers," Wisconsin Blue Book, 1977, p. 121-133; Harold P. Simonson, Zona Gale, notes that after reading Gale's works, Willa Cather commented: "I am haunted by Portage." (p. 4).

4) Simonson, pp. 37-45, 78-84.

5) Ibid., pp. 128-131. An analysis of the Glenn Frank controversy.

6) Information from Mrs. Virginia M. Laing of the Portage Women's Civic League.

7) Duluth, op. cit.

9. Major Bibliographical References

Wisconsin State Journal

11. Form Prepared By

Diane Filipowicz, Architectural Historian, Historic Preservation Division

State Historical Society of Wisconsin — May 29, 1980

816 State Street — (608) 262-2970

Madison — Wisconsin 53706

9. Major Bibliographical References

Capital Times
August Derleth, Still Small Voice: The Biography of Zona Gale, New York (1940)
Harold P. Simonson, Zona Gale, New York, (1962)
Wisconsin Blue Book, Madison (1977)

10. Geographical Data

Acreage of nominated property 0.18

Quadrangle name Portage, Wis. Quadrangle scale 1:62500

UMT References

	Zone	Easting	Northing
A	1 6	3 0 0 6 2 5	4 8 2 3 3 2 5
B			
C			
D			
E			
F			
G			
H			

Verbal boundary description and justification

The west 11-1/2 feet of lot 9, all of lot 10, and the east 10 feet of lot 11, of Block 60 of the MacFarland and Armstrong Addition to the city of Portage, Wisconsin.

List all states and counties for properties overlapping state or county boundaries

state	code	county	code

11. Form Prepared By

name/title Terry L. Shoptaugh, Historian, Historic Preservation Division

organization State Historical Society of Wisconsin date May 29, 1980

street & number 816 State Street telephone (608) 262-3390

city or town Madison state Wisconsin 53706

12. State Historic Preservation Officer Certification

The evaluated significance of this property within the state is:

x national ___ state ___ local

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89–665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the Heritage Conservation and Recreation Service.

State Historic Preservation Officer signature Richard Erney

title Director, State Historical Society of Wisconsin date 8/13/80

For HCRS use only
I hereby certify that this property is included in the National Register

date

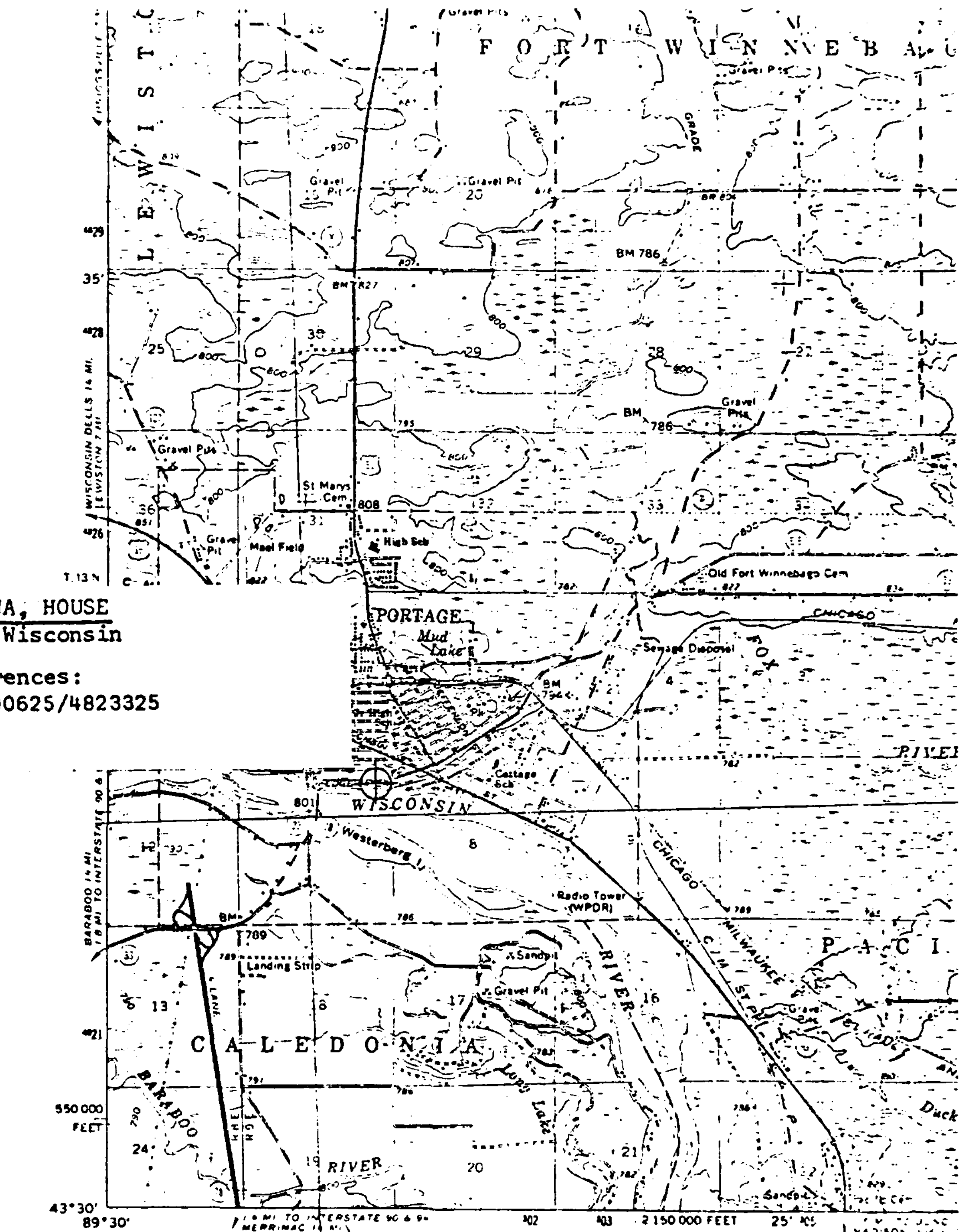
Keeper of the National Register

Attest: date

Chief of Registration

GALE, ZONA, HOUSE
Portage, Wisconsin

UTM References:
16/300625/4823325



Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

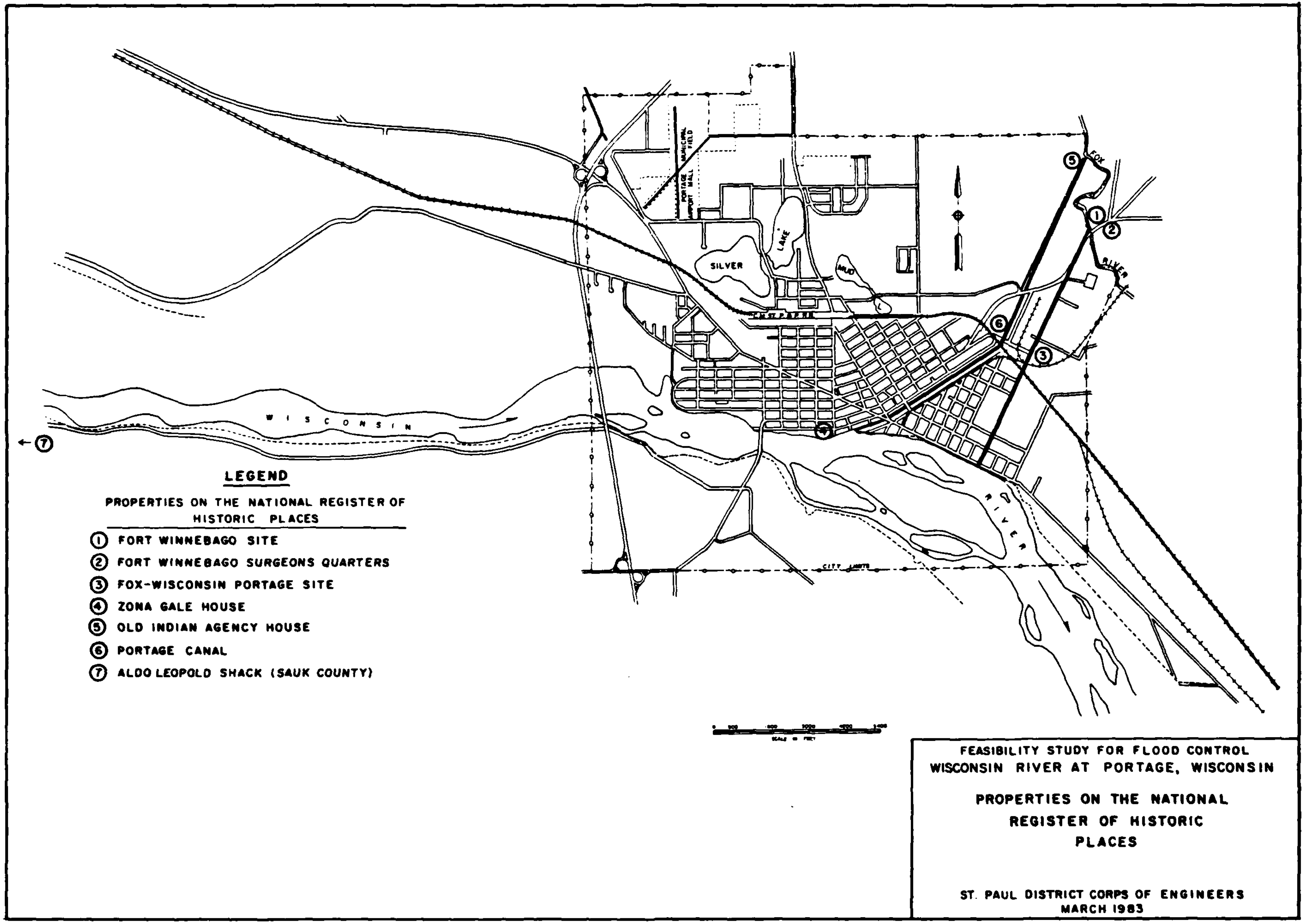
Topography by photogrammetric methods from aerial photographs taken 1960. Field checked 1962

Polyconic projection. 1927 North American datum
10,000-foot grid based on Wisconsin coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 16, shown in blue

Red tint indicates areas in which only landmark buildings are shown

UTM GRID AND 1962 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

FOR SALE
AND BY THE WISCONSIN
A FOLDER DESCR


FOX
RIVER
SILVER
LAKE
MUD L.
PORTAGE MUNICIPAL AIRPORT MALL FIELD
WISCONSIN
RIVER
CITY LIMITS
LEGEND
PROPERTIES ON THE NATIONAL REGISTER OF HISTORIC PLACES
1 FORT WINNEBAGO SITE
2 FORT WINNEBAGO SURGEONS QUARTERS
3 FOX-WISCONSIN PORTAGE SITE
4 ZONA GALE HOUSE
5 OLD INDIAN AGENCY HOUSE
6 PORTAGE CANAL
7 ALDO LEOPOLD SHACK (SAUK COUNTY)
FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER AT PORTAGE, WISCONSIN
PROPERTIES ON THE NATIONAL REGISTER OF HISTORIC PLACES
ST. PAUL DISTRICT CORPS OF ENGINEERS
MARCH 1983

MEMORANDUM OF AGREEMENT

WHEREAS, the U.S. Army Corps of Engineers (Corps) has determined that the proposed flood control project at Portage, Wisconsin, will have an effect upon properties included in or eligible for inclusion in the National Register of Historic Places and has requested the comments of the Advisory Council on Historic Preservation (ACHP) pursuant to Section 106 of the National Historic Preservation Act (16 U.S.C. 470) and its implementing regulations, "Protection of Historic and Cultural Properties (36 CFR Part 800)".

NOW, THEREFORE, the Corps, the Wisconsin State Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation agree that the undertaking shall be implemented in accordance with the attached stipulations in order to take into account the effect of the undertaking on historic properties.

Execution of this Memorandum of Agreement evidences that the Corps has afforded the Council a reasonable opportunity to comment on the proposed flood control project at Portage, Wisconsin, and its effects on historic properties and that the Corps has taken into account the effects of its undertaking on historic properties.

Edward G. Rapp 16 Nov 83

Army Corps of Engineers DATE

Wisconsin State Historic Preservation Officer DATE

Chairman, ACHP

Robert Garvey Dec 20, 1983

Executive Director, ACHP

STIPULATIONS

1. The Portage Lock and Canal will be dealt with in the following manner:

a. Work at the lock will include replacement of the upper set of existing gates. The gates on the upstream end of the lock will be approximately 7.0 feet shorter than the existing gates because of the construction of a concrete sill across the mouth of the lock. This sill provides stability to the floodwall and prevents the lock gates from silting in (see exhibit 1). A 5-foot draft will be maintained between the normal water surface in the lock and the top of the concrete sill. This draft would be ample for small-craft navigation if the lock were to be opened.

b. The new gates will be bolted shut and no opening mechanisms will be provided for in the present design. However, the bearings and struts to the gates will be replaced so that the gates could be made operable at a future date. The new gates will be horizontally framed out and be rivet-bolted so they will have the appearance of the existing riveted gates. If possible, the lifting mechanisms for the filling gates will be salvaged from the old gates; however, new gate handrails will replace the old handrails.

c. The concrete in the floodwall will be tinted and streaked to match the existing appearance of the lock.

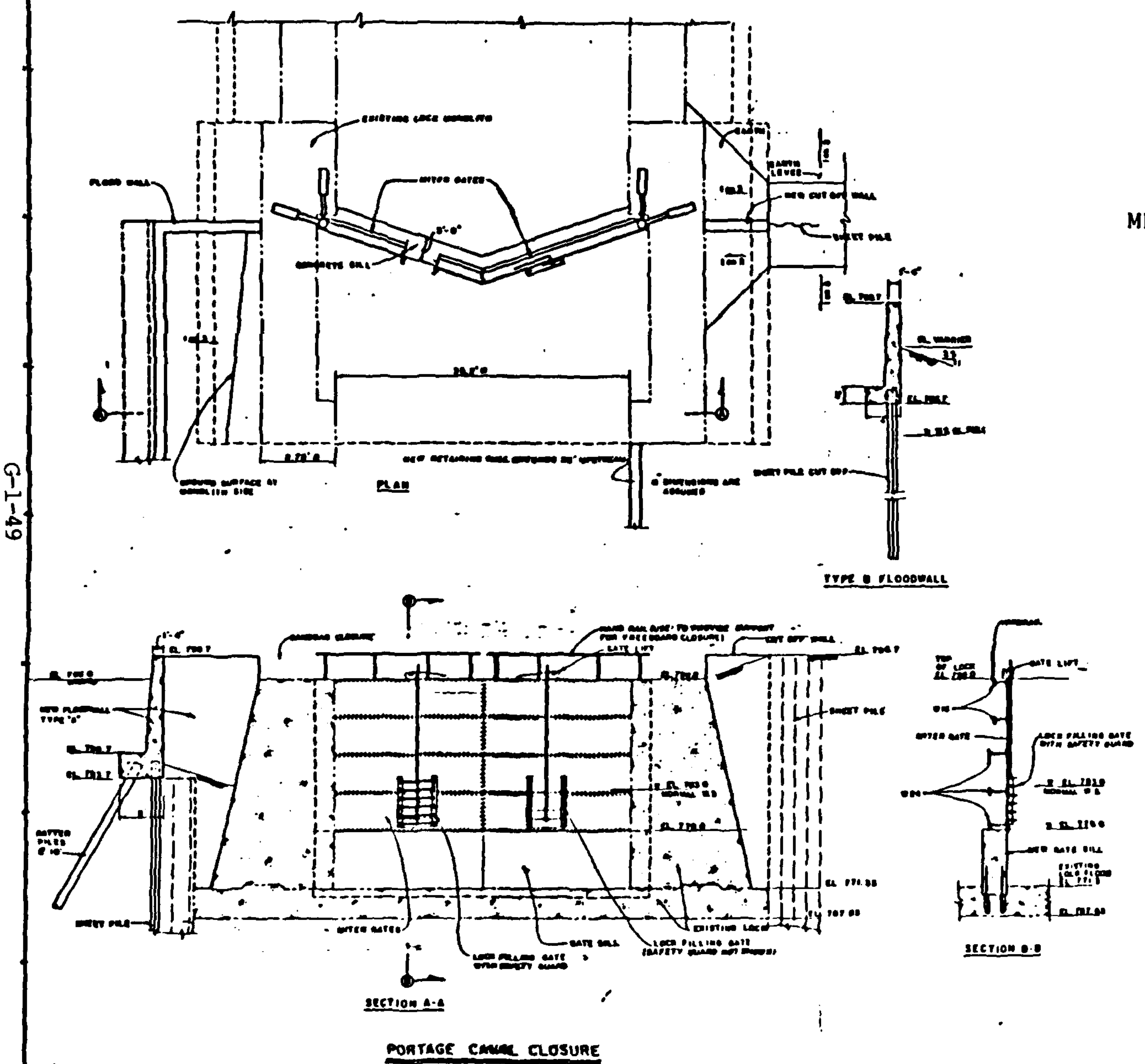
2. The Zona Gale House property sits at approximately elevation 805. The floodwall will be constructed along the 790-foot contour with the top of the floodwall at elevation 798.7. The floodwall will probably be backfilled for a portion or all of the 8.7-foot height. If the floodwall can be seen from the property, landscaping along the wall will retain the properly landscaped appearance with which Zona Gale was concerned when the house was constructed.

3. The Corps shall ensure that an archaeological survey of previously unassessed portions of the project's area of environmental effect is conducted, taking into account the professional standards identified in the Council's current Manual of Mitigation Measures and in consultation with the SHPO. If the survey results in the discovery of properties that in the opinion of the SHPO may be eligible for the National Register because they potentially could produce information important to the study of history or prehistory, the Corps shall ensure that such properties are treated in accordance with the stipulation regarding archaeological data recovery contained in point 4 of this Memorandum. If the survey results in the discovery of properties which the SHPO believes may be eligible for the National Register for other reasons, the Corps shall request further comments of the Council pursuant to 36 CFR Section 800.6(b).

4. The Corps shall ensure that, based on the principles in Part I of the Council's handbook, Treatment of Archaeological Properties, a plan is developed in consultation with the SHPO specifying: (1) which properties or portions of properties shall be subjected to data recovery; (2) which may be destroyed without such attention; and (3) what research questions shall be addressed by the data recovery effort and in what manner. The Corps shall ensure that the plan is responsive to the guidelines in Part III of the handbook. The Corps shall submit the plan to the SHPO and the Council for 15-day review. Unless the SHPO or the Council objects within 15 days after receipt of the plan, the Corps shall ensure that the plan is implemented.

5. Efforts to design the aforementioned features and any which arise as a result of the cultural resources surveys mentioned in point 3 will be closely coordinated with the Wisconsin State Historic Preservation Office, the Portage Canal Society, and the owners of the Zona Gale House.

EXHIBIT ONE
PORTAGE, WISCONSIN
MEMORANDUM OF AGREEMENT



PART 2

SOURCES OF ENVIRONMENTAL RESOURCE INFORMATION

SOURCES OF ENVIRONMENTAL RESOURCE INFORMATION

This section contains the following information on environmental resources in the Portage, Wisconsin, area.

a. Coordination Act Report, U.S. Fish and Wildlife Service, Green Bay Field Office, Green Bay, Wisconsin, 1 February 1979.

b. Abstract from the Draft Environmental Impact Statement for Wastewater Treatment Facilities for the City of Portage, Wisconsin, U.S. Environmental Protection Agency, Region V, Chicago, Illinois, November 1979.

Other sources of information on the natural resources of the Portage area are as follows:

a. Final Environmental Impact Statement, Columbia Generating Station, Wisconsin Power and Light Company, St. Paul District, Corps of Engineers, June 1974.

b. Final Environmental Impact Statement, Columbia Generating Station of the Wisconsin Power and Light Company, Wisconsin Department of Natural Resources, Bureau of Environmental Impact, November 1973.

c. Final Environmental Impact Statement, Portage Wastewater Treatment Facilities, Wisconsin Department of Natural Resources, Bureau of Environmental Impact, 3 March 1981.

U.S. FISH AND WILDLIFE SERVICE COORDINATION

Letters and Reports

February 1, 1979

January 16, 1981

January 14, 1982

United States Department of the Interior

FISH AND WILDLIFE SERVICE

GREEN BAY FIELD OFFICE (ES)

Univ. of Wisconsin—Green Bay
Green Bay, Wisconsin 54301

IN REPLY REFER TO:

February 1, 1979

Colonel Forrest T. Gay, III
District Engineer
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

This responds to your letter dated May 17, 1978, requesting baseline data on the fish and wildlife resources of the Wisconsin River near Portage, Wisconsin, and concerning the Portage Flood Control Project.

These comments are submitted in accordance with the Fish and Wildlife Coordination Act and are intended as technical assistance to aid your Stage I investigation.

STUDY AREA

The main study area is the Wisconsin River Floodplain from the Columbia-Sauk County line (river mile 122) near the village of Lewistown, downstream through Portage to the Interstate 90-94 bridge (river mile 106). Included are portions of Duck Creek and the Baraboo River as affected by Wisconsin River backwater (approximately 8 miles above the mouth of each), and the Fox River as affected by Wisconsin River backwater and overflows (Figure 1).

FISHERY RESOURCES

The Wisconsin River flows for approximately 400 miles across the state and joins the Mississippi River at Prairie du Chien. The river supports a variety of aquatic habitats including oxbow lakes, side channels, sloughs, swift water environs, and a diversity of wetlands. Sand is the primary bottom material, with lesser amounts of silt, gravel, rubble, boulder, and exposed bedrock.

The Wisconsin River, with its connection to the Mississippi River, and the Fox River, with its connection to the Great Lakes, is a major distribution route for the northward and eastward movement of fishes. Because of the different aquatic habitats previously described, the river supports a diversity of fish. For example, 82 species representing 20 families were found in a comprehensive survey of the Wisconsin River from the dam at Prairie du Sac, Sauk County, to its mouth. Several sampling surveys conducted farther upstream revealed that at least 61 species of fish are known to occur in the Wisconsin River portion of the study area, which

includes parts of the lower Baraboo River, Upper Fox River, and several smaller tributary streams. Clearly, this riverine complex comprises a high diversity of fishes and is a valuable resource to central Wisconsin. Appendix A lists those species known to occur in the study area (most species documentation was taken from unpublished information provided by Dr. George Becker, Professor of Biology, University of Wisconsin-Stevens Point, Wisconsin).

Warm water game fish caught by sport fishermen in the study area, and in other sections of the river include walleye, sauger, perch, muskellunge, northern pike, largemouth and smallmouth bass, white bass, bluegill, crappie and catfish. Walleye, sauger, and smallmouth bass often congregate in swift water near rocky shoal areas and in the tailwaters of the hydro-electric dams that impound the river. Muskellunge, northern pike, large-mouth bass and white bass, as well as several panfish species, are found in side channels and shallow backwater areas where aquatic vegetation, stumps, and other natural materials provide habitat for spawning, nursery, and concealment. Catfish can tolerate turbid or silty conditions and prefer deep holes, undercut banks, or depressions under rocks.

Class I trout streams (high grade trout waters with conditions favorable for natural reproduction) in the study area of Columbia County are Durward Glen Creek (brook), Roelke Creek (brook and brown) and Rowan Creek (brook, brown, and rainbow). Hinkson Creek (brook), Rocky Run Creek (brook and brown) and Jennings Creek (brook) are Class II trout streams (support some natural reproduction but require moderate to heavy stocking to maintain good fishing). Finally, Duck Creek (brook and brown) is a Class III stream which contains marginal trout habitat and stocking legal trout is necessary to provide trout fishing (Wisconsin Department of Natural Resources, Wisconsin Trout Streams, Publication 6-3600 [76]).

Nongame fish inhabiting the Wisconsin River include carp, bullhead, redhorse, sucker, shad, darters and several species of minnows and shiners. Although all fish contribute to the functioning of the aquatic ecosystem, certain species such as minnows and shiners provide a particularity important link as a forage base in the food chain. Others, such as darters, may provide indication of good water quality.

A small amount of commercial fishing occurs in the Wisconsin River and none in the Fox River within the project area. The Surface Water Resources of Columbia County (Wisconsin Department of Natural Resources, 1965) reports that one commercial fisherman is licensed to remove rough fish from the Wisconsin River between the Interstate 90-94 bridge and Wisconsin Dells. This removal operation is primarily conducted during the winter by seining under the ice. In addition to carp, which is the primary species sought, fewer numbers of northern pike, walleye, channel catfish, crappies and white suckers are captured, but released. Thus, the commercial fishery in the project area is useful to a small extent for management of rough fish populations which helps to maintain populations of game fish.

According to the Surface Water Resources of Columbia County (Wisconsin Department of Natural Resources, 1965), approximately 9,000 residents and 10,000 non-residents purchase fishing licenses yearly in Columbia County. Information concerning angler use and success, and harvest of game fishes in the specific area of this study is not available. There has been no creel census or other research, to our knowledge, concerning fishing pressure. However, it is known that Lake Wisconsin and the Wisconsin River could provide more fishing than any other bodies of water in Columbia County. Also, there are fewer restrictions to fishing these waters. County parks along the Fox River in Columbia County have been planned for construction. Thus, access to these fishing areas will be important for sport fishermen.

Information concerning benthic communities in the study area is very limited. In May, 1972, a biological survey of bottom sediments of two bays of Lake Wisconsin and of a transect across the river was conducted. The river transect consisted of a sandy bottom substrate overlain with a shallow (1/2-2 inch) layer of organic sediment. The organic sediment was composed of silt loam, small sticks and some leaf debris. Twelve species, primarily consisting of Oligocheates and Dipterans, were found in six dredge samples. However, it should be noted that the data was collected a considerable distance downstream from the study area.

WILDLIFE RESOURCES

The diversity of birds, mammals, reptiles and amphibians in the study area is great compared to the region or the rest of the state (Appendix A). Forty-eight mammal species, 38 amphibian and reptile species, and 237 species of birds are known or thought to inhabit various niches within the study area. Many of the birds listed migrate through the area enroute to more northern nesting grounds. Because of the extensive agricultural lands surrounding the study area, the Wisconsin River, with its adjacent wetlands and wooded areas, serves as an important migration route.

Forty-eight species of mammals have been recorded in the study area. Small game animals include eastern cottontail, gray and fox squirrels, and raccoons. The eastern cottontail inhabits grassy and weedy patches and thickets on farms, brushy fencerows, woodlands with numerous thickets, brush piles, and fallen trees. Although the fox squirrel prefers open hardwood woodlands and groves in rolling agricultural country, they are commonly found with the gray squirrels in areas with brushy undergrowth along rivers and on wooded bluffs. Raccoons inhabit forested and semi-open country with abundant water sources and wet marshes.

Stable populations of mink and muskrat are found in the Wisconsin River floodplain, and trapping them provides recreation for local residents as well as a supplement to their income. Beaver, otter, and weasel trapping is also permitted except on some state-owned wetlands where beaver dams benefit waterfowl and muskrats.

White-tailed deer are abundant on the floodplain in woodland borders and adjacent open fields.

Twenty-three species of waterfowl migrate through the area, and six species nest there. The many backwaters provide important brood areas as well as resting and staging areas during migrations. The timbered bottomland provides ideal habitat for wood ducks and reproduction is excellent. Waterfowl hunting is an important recreational activity in the area.

Upland game birds of the area include ruffed grouse, bobwhite, and ring-necked pheasant. Ruffed grouse prefer young forests or mature forests that have been thinned. Bobwhite inhabit brushy patches, abandoned fields, and the floodplain woods. The bobwhite was formerly more abundant, but has declined due to the destruction of shrubby habitat along fields, woodlands, floodplain, and roadsides. Ring-necked pheasants are stocked on state hunting grounds because of high demand by hunters. Suitable winter cover is found along the Wisconsin River, and some natural reproduction of pheasants occurs.

Recreational uses in the area include trapping, hunting, fishing, bird-watching, camping, nature study, canoeing, boating, and hiking. These types of recreation depend on diverse wildife resources.

ENVIRONMENTALLY SENSITIVE AREAS

1. There are three Department of Natural Resources public hunting grounds within the designated study area which provide prime wildife and recreation resources. Swan Lake Public Hunting area is located between Swan Lake and Portage and Pine Island and Dekorra Hunting areas are located west of Portage along the Wisconsin River.

2. The Swan Lake section of the Fox River is excellent for wildlife. It encompasses marsh, prairie, woodland and open water which provide breeding habitat for many wildlife species. Particular to this area are the Henslow's grasshopper, savannah, and lark sparrow, which are an attraction to bird watchers.

3. Dr. George Archibald of the International Crane Foundation indicates that the area west of Portage, immediately north of the Wisconsin River and north of the Sauk County line, contains some of Wisconsin's most productive sandhill crane habitat. This includes the area across the Wisconsin River north of the Leopold Memorial Reserve.

4. The Leopold Memorial Reserve is a National Historic Landmark and an area of extreme importance. This reserve is composed of approximately 1,200 acres of land along the Wisconsin River in Sauk County, Fairfield Township, T13N, R7E and Government Islands 8 and 9 in the Wisconsin River, Columbia County. It was here, in and around his still standing cabin, that the late Aldo Leopold wrote some of his famous works. He also wrote about the immediate area. Leopold is often called the "Father of Wildlife Management," and is considered a great naturalist, writer and educator.

5. The Portage area of the Fox and Wisconsin Rivers is considered to have some of the best wildlife habitat in the region. The bottomlands west of Portage are some of the most productive along the entire river. In terms of recreation, hunting, and fishing, it is important to preserve this fine wildife habitat.

In general, the condition of the existing wildlife population appears to be stable. This floodplain area within the Wisconsin River Basin is one of the few remaining natural resource areas within southern Wisconsin. The floodplain woods and marshes are rich in their diversity and abundance of plants and wildlife. Lists of birds, mammals, reptiles, amphibians and fishes are provided in Appendix A. However, as indicated by the continuing decline of species such as red-shouldered hawks, bald eagles, peregrine falcons, wood ducks, and osprey, these floodplain wood and marsh habitats are critical to wildlife for migration, wintering and breeding. The red-shouldered hawk is a prime example because so much river bottom habitat needed for breeding is being destroyed.

THREATENED AND ENDANGERED SPECIES

Endangered species are described by the Wisconsin Department of Natural Resources as those species that are in immediate danger of extinction within Wisconsin and whose continued survival is unlikely without the implementation of special protective measures. Threatened species are those species that appear likely to become endangered within the foreseeable future. State and Federal threatened and endangered species that inhabit or migrate through the study area are listed in Appendix A and discussed below.

Red-shouldered Hawk (*Buteo lineatus*)

This species occupies river bottom woods. Stream channelization, floodplain encroachment by development, and the impoundment of the Wisconsin River by dams have substantially reduced this hawk's prime habitat. Also, water pollution, especially pesticide contaminants, threaten its existance.

Bald Eagle (*Haliaeetus leucocephalus*)

Bald eagles use the Wisconsin and Mississippi Rivers as migration routes and wintering areas. A site just north of Portage on the Wisconsin River is a common wintering area for eagles. Numbers of eagles have declined due to pesticides, human encroachment on nesting areas and illegal shooting. The food of bald eagles consists mainly of fish.

American Osprey (*Pandion haliaetus*)

Osprey have never been common, but formerly bred in suitable localities all over the state. Ospreys pass through the study area as migrants. They prefer large, dead trees, such as tall solitary white pine or large oaks in the vicinity of a stream or lake with an abundant fishery resource. Osprey have declined due to reproductive failure caused by environmental pollutants (DDT), as well as by encroachment on habitat and human disturbance.

Peregrine Falcon (*Falco peregrinus*)

Peregrine falcons are gone as a breeding bird east of the Mississippi River. In the 1940's and 1950's, they bred along the Wisconsin and Mississippi Rivers in Wisconsin. They now occasionally pass through as migrants along these rivers.

Double-crested Cormorant (*Phalacrocorax auritus*)

The double-crested cormorant was a common migrant and breeder in Wisconsin up until the late 1950's. Numbers of migrating and breeding cormorants have declined greatly since then, with only a few of the rookeries still holding small numbers of birds. The Wisconsin River is used primarily as a migration route. The decline is believed to be due to human-induced habitat loss, deterioration, and disturbance.

There are no known endangered or threatened plant species in or near the proposed study area.

FUTURE STUDY AREA SETTING

A speculative discussion of the future area setting (50 year planning period) requires that certain assumptions be made. We are assuming that the following conditions will significantly affect the future quality and quantity of fish and wildlife habitat in the study area.

Floodplain encroachment by private and agricultural development will likely continue to cause floodplain modifications and flooding problems. However, it is the natural process of flooding which helps to maintain the great diversity and production in the wildife, fishery, and vegetative aspects of the floodplain environment.

The results of this Corps study, particularly the selected plan, could potentially have significant impacts on fish and wildlife resources, depending on which solution is implemented.

The Wisconsin Department of Natural Resources will likely continue managing the fishery of the Wisconsin River as well as wildlife populations on area hunting lands (Pine Island, Swan Lake and Dekorra). This is in an effort to optimize wildlife diversity for sportsmen and other wildlife oriented enthusiasts.

Water quality should slowly improve in the Wisconsin River with subsequent improvement to aquatic life as further compliance with the Federal Water Pollution Control Act Amendments of 1972 is implemented.

We are not aware of any significant changes in policies or plans by the Wisconsin Department of Natural Resources or the Fish and Wildlife Service that would change substantially the existing study area environment in the near future.

We hope this information is helpful in your project planning.

Sincerely yours,

R. A. Hoppe

Richard A. Hoppe
Field Supervisor

cc: WDNR, Madison, WI
WDNR, Dodgeville, WI
U.S. EPA, Chicago, IL
Ms. Nina Bradley, Baraboo, WI

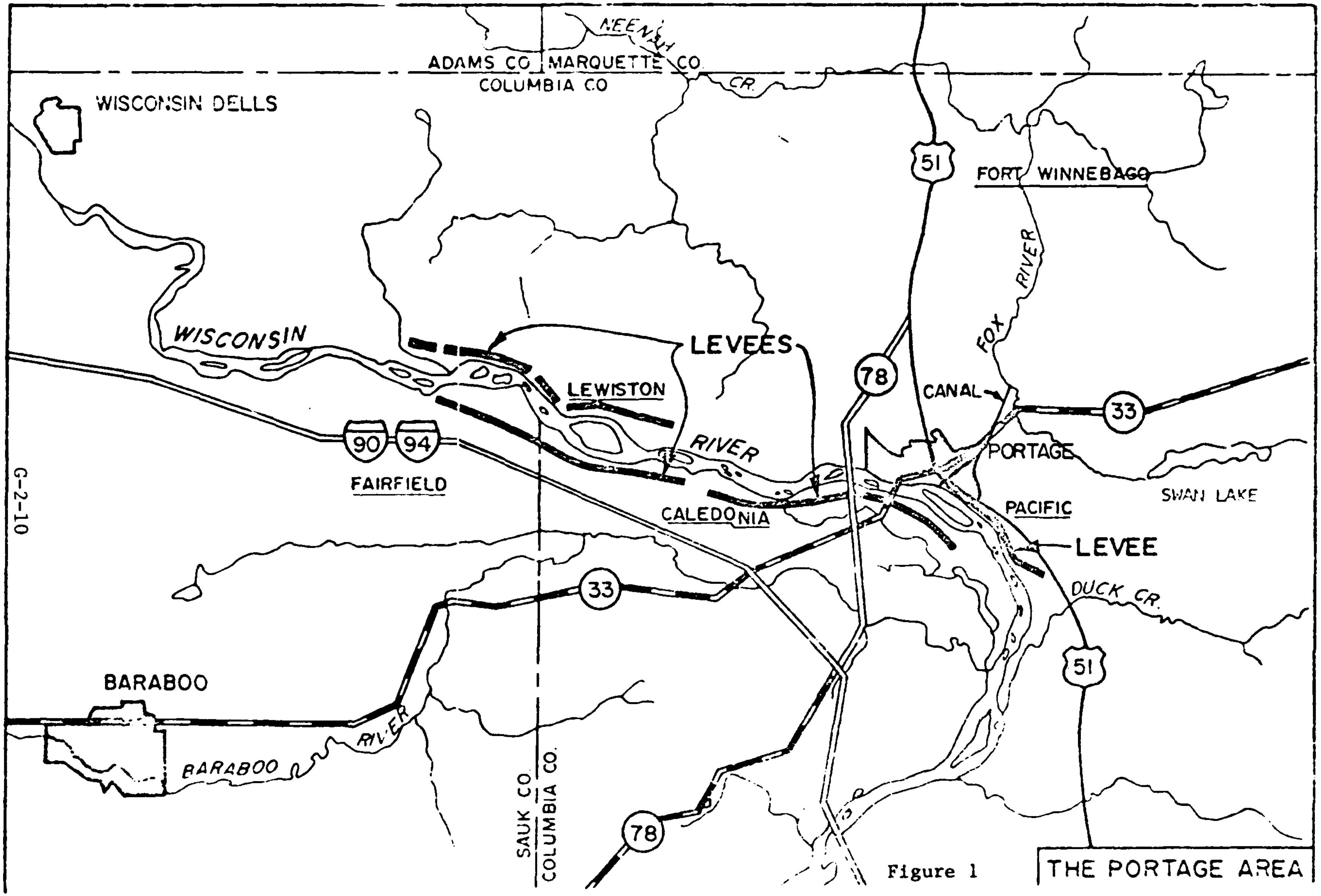


Figure 1

THE PORTAGE AREA

APPENDIX A

List of fish species known to occur in the study area.

	Common Name	Scientific Name
1.	Lake sturgeon	Acipenser fulvescens
2.	Shovelnose sturgeon	Scaphirhynchus platorynchus
3.	Longnose gar	Lepisosteus osseus
4.	Gizzard shad	Dorosoma cepedianum
5.	Rainbow trout	Salmo gairdneri
6.	Brown trout	Salmo trutta
7.	Brook trout	Salvelinus fontinalis
8.	Central mudminnow	Umbra limi
9.	Northern pike	Esox lucius
10.	Muskellunge	Esox masquinongy
11.	Carp	Cyprinus carpio
12.	Brassy minnow	Hybognathus hankinsoni
13.	Speckled chub	Hybopsis aestivalis
14.	Golden shiner	Notemigonus crysoleucas
15.	Emerald shiner	Notropis atherinoides
16.	River shiner	Notropis blennius
17.	Bigmouth shiner	Notropis dorsalis
18.	Blackchin shiner	Notropis heterodon
19.	Blacknose shiner	Notropis heterolepis
20.	Spotfin shiner	Notropis spilopterus
21.	Sand shiner	Notropis stramineus

Common Name		Scientific Name
22.	Northern redbelly dace	Phoxinus eos
23.	Bluntnose minnow	Pimephales notatus
24.	Flathead minnow	Pimephales promelas
25.	Bullhead minnow	Pimephales vigilax
26.	River carpsucker	Carpiodes carpio
27.	Highfin carpsucker	Carpiodes velifer
28.	White sucker	Catastomus commersoni
29.	Shorthead (northern) redhorse	Moxostoma macrolepidotum
30.	Black bullhead	Ictalurus melas
31.	Yellow bullhead	Ictalurus natalis
32.	Channel catfish	Ictalurus punctatus
33.	Tadpole madtom	Noturus gyrinus
34.	Flathead catfish	Pylodictis olivaris
35.	Pirate perch	Aphredoderus sayanus
36.	Banded Killifish	Fundulus disphanus
37.	Blackstripe topminnow	Fundulus notatus
38.	Brook silversides	Labidesthes sicculus
39.	Brook stickelback	Culaea inconstans
40.	White bass	Morone chrysops
41.	Yellow bass	Morone mississippiensis
42.	Rock bass	Ambloplites ruperstris
43.	Green sunfish	Lepomis cyanellus

	Common Name	Scientific Name
44.	Pumpkinseed	Lepomis gibbosus
45.	Warmouth	Lepomis gulosus
46.	Bluegill	Lepomis macrochirus
47.	Smallmouth bass	Micropterus dolomieui
48.	Largemouth bass	Micropterus salmonides
49.	White crappie	Pomoxis annularis
50.	Black crappie	Pomoxis nigromaculatus
51.	Western sand darter	Ammocrypta clara
52.	Rainbow darter	Etheostoma caeruleum
53.	Iowa darter	Etheostoma exile
54.	Johnny darter	Etheostoma nigrum
55.	Banded darter	Etheostoma zonale
56.	Yellow perch	Perca flavescens
57.	Logperch	Percina caprodes
58.	River darter	Percina shumardi
59.	Sauger	Stizostedion canadense
60.	Walleye	Stozostedion vitreum vitreum
61.	Freshwater drum	Aplodinotus grunniens

List of birds known or thought to be present.

Key: a-abundant — c-common — u-uncommon — o-occasional — r-rare — n-not present in this season — * breeds in area

	Common Name	Scientific Name	S	S	F	W
1.	Common Loon	Gavia immer	u	n	u	n
2.	Horned Grebe	Podiceps auritus	u	n	u	n
3.	Pied-billed Grebe*	Podilymbus podiceps	c	c	c	n
4.	Double-crested Cormorant	Phalacrocorax auritus	o	o	u	n
5.	Whistling Swan	Olor columbianus	c	n	c	n
6.	Canada Goose*	Branta canadensis	c	u	c	u
7.	Snow Goose	Chen caerulescens	u	n	u	n
8.	Mallard*	Anas platyrhynchos	a	a	a	c
9.	Black Duck	Anas rubripes	c	u	c	o
10.	Pintail	Anas acuta	c	r	c	r
11.	Gadwall	Anas strepera	c	u	c	n
12.	American Widgeon	Anas americana	c	u	c	n
13.	Northern Shoveller	Anas clypeata	c	u	c	n
14.	Blue-winged Teal*	Anas discors	c	u	c	n
15.	American Green-winged Teal	Anas crecca	u	r	u	r
16.	Wood Duck*	Aix sponsa	c	a	a	r
17.	Redhead	Aythya americana	u-c	r	u-c	r
18.	Canvasback	Aythya valisineria	u-c	r	u-c	r
19.	Ring-necked Duck	Aythya collaris	c	r	c	r

	Common Name	Scientific Name	S	S	F	W
20.	Greater Scaup	Aythya marila	u	n	u	n
21.	Lesser Scaup	Aythya affinis	c	u	c	r
22.	Common Goldeneye	Bucephala clangula	u	n	u	o
23.	Bufflehead	Bucephala albeola	c	n	c	r
24.	Ruddy Duck	Oxyura jamaicensis	u	r	u	n
25.	Common Merganser	Mergus merganser	u	n	u	o
26.	Red-breasted Merganser	Mergus serrator	u	n	u	r
27.	Hooded Merganser	Lophodytes cucullatus	c	u	c	r
28.	Turkey Vulture	Cathartes aura	c	c	c	r
29.	Goshawk	Accipites gentilis	r	r	r	o
30.	Cooper's Hawk	Accipiter cooperii	u	u	u	o
31.	Sharp-shinned Hawk	Accipiter striatus	c	u	c	o
32.	Harrier*	Circus cyanlus	u	u	u	r
33.	Rough-legged Hawk	Buteo lagopus	u-c	n	u-c	u-c
34.	Red-tailed Hawk*	Buteo jamarcensis	c	c	c	c
35.	Red-shouldered Hawk*	Buteo lineatus	u	u	u	r
36.	Broad-winged Hawk*	Buteo platypterus	u	o	u	n
37.	Golden Eagle	Aquila chrysaetos	r	n	r	r
38.	Bald Eagle	Haliaeetus leucocephalus	c	u	c	c
39.	Osprey	Pandion haliaetus	u	o	o	r
40.	Peregrine Falcon	Falco peregrinus	r	r	r	n
41.	American Kestrel	Falco sparverius	c	c	c	u
42.	Ruffed Grouse*	Bonasa umbellus	c	c	c	c

	Common Name	Scientific Name	S	S	F	W
43.	Bobwhite*	Colinus virginianus	u-c	u-c	u-c	u-
44.	Ring-necked Pheasant*	Phasianus colchicus	u	u	u	u
45.	Gray Partridge*	Perdix perdix	u	u	u	u
46.	Great Egret	Casmerodius albus	u	u	u	n
47.	Great Blue Heron	Ardea herodias	c	c	c	r
48.	Green Heron*	Butorides virescens	c	c	c	n
49.	Black-crowned Night Heron	Nycticorax nycticorax	c	c	c	n
50.	Yellow-crowned Night Heron	Nyctanassa violacea	o	o	o	n
51.	American Bittern	Botaurus lentiginosus	u	u	u	n
52.	Least Bittern	Ixobrychus exilis	u	u	u	n
53.	Sandhill Crane*	Grus canadensis	u	u	u	n
54.	Virginia rail	Rallus limicola	u	u	u	n
55.	Sora Rail*	Porzana carolina	c	c	c	n
56.	Common Gallinule	Gallinula chloropus	u	u	u	n
57.	American Coot	Furlica americana	c	u	c	o
58.	American Golden Plover	Pluvialis dominica	u	n	u	n
59.	Black-bellied Plover	Pluvialis squatarola	o	n	o	n
60.	Semipalmated Plover	Charadrius semipalmatus	u	u	u	n
61.	Killdeer*	Charadrius vociferous	c	c	c	r
62.	Upland Sandpiper*	Bartramia longicauda	o	o	o	n
63.	Solitary Sandpiper	Tringa solitaria	u	u	u	n

Common Name	Scientific Name	S	S	F	W
64. Spotted Sandpiper*	Actitis macularia	c	c	c	n
65. Greater Yellowlegs	Tringa melanoleucus	u	u	u	n
66. Lesser Yellowlegs	Tringa flavipes	u	u	u	n
67. Stilt Sandpiper	Micropalama himantopus	o	o	o	n
68. Short-billed Dowitcher	Limnodromus griseus	u	u	u	n
69. Long-billed Dowitcher	Limnodromus scolopaceus	u	u	u	n
70. Pectoral sandpiper	Calidris melanotos	u	u	u	n
71. Dunlin	Calidris alpina	u	u	u	n
72. Sanderling	Calidris alba	u	u	u	n
73. White-rumped Sandpiper	Calidris fuscicollis	u	u	u	n
74. Baird's Sandpiper	Calidris bairdii	u	u	u	n
75. Least Sandpiper	Calidris minutilla	u	u	u	n
76. Semipalmated Sandpiper	Calidris pusillus	u	u	u	n
77. Wilson's Phalarope	Steganopus tricolor	u	u	u	n
78. American Woodcock*	Philohela minor	u	u	u	n
79. Common Snipe	Capella gallinago	c	u	c	o
80. Herring Gull	Larus argentatus	c	o	c	u
81. Ring-billed Gull	Larus delawarensis	c	o	c	u
82. Franklin's Gull	Larus pipixcan	o	n	o	n
83. Bonaparte's Gull	Larus philadelphia	o	n	o	n
84. Common Tern	Sterna hirundo	u	u	u	n

	Common Name	Scientific Name	S	S	F	W
85.	Forster's Tern	Sterna forsteri	u	o	u	n
86.	Caspian Tern	Hydroprogne caspia	o	n	o	n
87.	Black Tern	Chlidonias niger	c	c	u	n
88.	Rock Dove*	Columbia livia	c	c	c	c
89.	Mourning Dove*	Zenaida macroura	c	c	c	u
90.	Yellow-billed Cuckoo*	Coccyzus americanus	c	c	u	n
91.	Black-billed Cuckoo*	Coccyzus erythropthalmus	c	c	u	n
92.	Barn Owl*	Tyto alba	o	o	o	o
93.	Screech Owl*	Otus asio	u	u	u	u
94.	Great Horned Owl*	Bubo virginianus	c	c	c	c
95.	Long-eared Owl*	Asio otus	u	u	u	u
96.	Short-eared Owl	Asio flammeus	u	n	u	u
97.	Barred Owl*	Strix varia	c	c	c	c
98.	Saw-whet Owl*	Aegolius acadius	u	u	u	u
99.	Whip-poor-will*	Caprimulgus vociferus	c	c	c	n
100.	Common Nighthawk*	Chordeiles minor	c	a	u	n
101.	Chimney Swift*	Chaetura pelagica	c	a	u	n
102.	Ruby-throated Hummingbird*	Archilochus colubris	u	u	u	n
103.	Belted Kingfisher*	Megaceryle alcyon	c	c	u	o
104.	Common Flicker*	Colaptes auratus	c	c	c	u
105.	Pileated Woodpecker*	Dryocopus pileatus	u	u	u	u

	Common Name	Scientific Name	S	S	F	W
106.	Red-bellied Woodpecker*	Centurus carolinus	c	c	c	c
107.	Red-headed Woodpecker*	Melanerpes erythrocephalus	c	c	c	u
108.	Yellow-bellied Sapsucker*	Sphyrapicus varius	u	o	u	r
109.	Hairy Woodpecker*	Dendrocopos villosus	c	c	c	c
110.	Downy Woodpecker*	Dendrocopos pubescens	c	c	c	c
111.	Eastern Kingbird*	Tyrannus tyrannus	c	c	u	n
112.	Great Crested Flycatcher*	Myiarchus crinitus	c	c	u	n
113.	Eastern Phoebe*	Sayornis phoebe	c	c	c	n
114.	Yellow-bellied Flycatcher	Empidonax flaviventris	u	u	u	n
115.	Alder Flycatcher	Empidonax alhorum	u	n	u	n
116.	Willow Flycatcher*	Empidonax traillii	u	u	u	n
117.	Least Flycatcher*	Empidonax minimus	c	c	u	n
118.	Eastern Wood Pewee*	Contopus virens	c	c	c	n
119.	Olive-sided Flycatcher	Nuttallornis borealis	u	u	u	n
120.	Barn Swallow*	Hirundo rustica	a	a	c	n
121.	Cliff Swallow*	Petrochelidon pyrrhonota	u-c	u-c	u-c	n
122.	Tree Swallow*	Iridoprocne bicolor	a	a	c	n
123.	Bank Swallow*	Riparia riparia	c	c	u	n
124.	Rough-winged Swallow*	Stelgidopteryx ruficollis	c	c	u	n
125.	Purple Martin*	Progne subis	c	c	u	n
126.	Blue Jay*	Cyanocitta cristata	c	c	c	c

	Common Name	Scientific Name	S	S	F	W
127.	Common Crow*	Corvus brachyrhynches	c	c	c	c
128.	Black-capped Chickadee*	Parus atricapillus	c	c	c	c
129.	Tufted Titmouse*	Parus bicolor	c	c	c	c
130.	White-breasted Nuthatch*	Sitta carolinensis	c	c	c	c
131.	Red-breasted Nuthatch	Sitta canadensis	o	o	o	o
132.	Brown Creeper*	Certhia familiaris	c	o	c	u
133.	House Wren*	Troglodytes aedon	a	a	c	n
134.	Winter Wren	Troglodytes troglodytes	u	u	u	r
135.	Long-billed Marsh Wren*	Telmatodytes palustris	c	c	u	n
136.	Short-billed Marsh Wren*	Cistothorus platensis	u	u	u	n
137.	Grey Catbird*	Dumetella carolinensis	c	c	c	n
138.	Brown Thrasher*	Toxostoma rufum	c	c	c	n
139.	American Robin*	Turdus migratorius	a	a	a	o
140.	Wood Thrush*	Catharis mustelina	c	c	u	n
141.	Hermit Thrush	Catharis guttata	u-c	n	u-c	n
142.	Swainson's Thrush	Catharis ustulata	c	n	c	n
143.	Gray-cheeked Thrush	Catharis minima	u	n	u	n
144.	Veery*	Catharis fuscescens	c	u	c	n
145.	Eastern Bluebird*	Sialia sialis	u-c	u-c	u-c	r
146.	Blue-gray Guatcatcher*	Potioptila caerulea	u	u	n	n
147.	Golden-crowned Kinglet	Regulus strapa	u-c	n	u-c	u-c

	Common Name	Scientific Name	S	S	F	W
148.	Ruby-crowned Kinglet	Regulus calendula	c	n	c	n
149.	Water Pipit	Anthus spinoletta	u	n	u	n
150.	Cedar Waxwing*	Bombycilla cedrorum	c	c	c	u
151.	Northern Shrike	Lanius excubitor	r	n	o	o
152.	Loggerhead Shrike*	Lanius ludovicianus	o	o	o	n
153.	Starling*	Sturnus vulgaris	a	a	a	a
154.	Solitary Vireo	Vireo solitarius	u	n	u	n
155.	Bell's Vireo*	Vireo bellii	o	o	o	n
156.	Yellow-throated Vireo*	Vireo flavifrons	c	c	c	n
157.	Red-eyed Vireo*	Vireo olivaceus	c	c	a	n
158.	Philadelphia Vireo	Vireo philadelphicus	u	n	u	n
159.	Warbling Vireo*	Vireo gilvus	c	c	c	n
160.	Black-and-white Warbler*	Mniotilta varia	c	u	c	n
161.	Prothonotary Warbler*	Protonotaria citrea	u	u	u	n
162.	Golden-winged Warbler	Vermivora chrysoptera	u	u	u	n
163.	Blue-winged Warbler*	Vermivora pinus	u	u	u	n
164.	Tennessee Warbler	Vermivora peregrina	c	n	c	n
165.	Orange-crowned Warbler	Vermivora celata	o	n	o	n
166.	Nashville Warbler	Vermivora ruficapilla	c	n	c	n
167.	Northern Parula Warbler	Parula americana	u	n	u	n
168.	Yellow Warbler*	Dendroica petechia	a	a	o	n

	Common Name	Scientific Name	S	S	F	W
169.	Magnolia Warbler	Dendroica magnolia	u	n	u	n
170.	Cape May Warbler	Dendroica tigrina	u	n	u	n
171.	Yellow-rumped Warbler	Dendroica coronata	a	n	a	n
172.	Black-throated Green Warbler	Dendroica virens	u	n	u	n
173.	Black-throated Blue Warbler	Dendroica caerulescens	u	n	u	n
174.	Cerulean Warbler*	Dendroica cerulea	u	u	u	n
175.	Blackburnian Warbler	Dendroica fusca	u	n	u	n
176.	Chestnust-sided Warbler	Dendroica pensylvanica	u	n	u	n
177.	Bay-breasted Warbler	Dendroica castanea	u	n	u	n
178.	Blackpoll Warbler	Dendroica striata	u	n	u	n
179.	Pine Warbler	Dendroica pinus	u	n	u	n
180.	Palm Warbler	Dendroica palmarum	c	n	c	n
181.	Ovenbird*	Seiurus aurocapillus	u	u	u	n
182.	Northern Waterthrush	Seiurus noveboracensis	u	n	u	n
183.	Common Yellowthroat*	Geothlypis trichas	a	a	c	n
184.	Yellow-breasted Chat*	Icteria virens	r	r	r	n
185.	Kentucky Warbler	Oporornis formosus	u	n	u	n
186.	Nourning Warbler	Oporornis philadelphia	u	n	u	n
187.	Connecticut Warbler	Oporornis agilis	u	n	u	n
188.	Wilson's Warbler	Wilsonia pusilla	u	n	u	n
189.	Canada Warbler	Wilsonia canadensis	u	n	u	n

	Common Name	Scientific Name	S	S	F	W
190.	American Redstart*	Setophaga ruticilla	a	a	c	n
191.	House Sparrow*	Passer domesticus	a	a	a	a
192.	Bobolink*	Dolichonyx oryzivorus	u	u	u	n
193.	Eastern Meadowlark*	Sturnella magna	c	c	c	o
194.	Western Meadowlark*	Sturnella neglecta	a	a	a	o
195.	Yellow-headed Blackbird	Xanthocephalus xanthocephalus	r	r	r	n
196.	Red-winged Blackbird*	Agelaius phoeniceus	a	a	a	u
197.	Rusty Blackbird*	Euphagus carolinus	c	n	c	o
198.	Brewer's Blackbird*	Euphagus cyanocephalus	u	u	u	r
199.	Common Grackle*	Quiscalus quiscula	a	a	a	u
200.	Brown-headed Cowbird	Molothrus ater	a	a	a	r
201.	Orchard Oriole*	Icterus spurius	o	o	o	n
202.	Northern Oriole*	Icterus galbula	c	c	c	n
203.	Scarlet Tanager*	Piranga olivacea	u	u	u	n
204.	Cardinal*	Cardinalis cardinalis	c	c	c	c
205.	Rose-breasted Grosbeak*	Pheucticus ludovicianus	c	c	c	n
206.	Evening Grosbeak	Hesperiphona vespertina	o	n	o	u
207.	Indigo Bunting*	Passerina cyanea	c	c	c	n
208.	Purple Finch	Carpodacus purpureus	c	n	c	u
209.	Pine Grosbeak	Pinicola enucleator	r	n	r	r
210.	Common Redpoll	Acanthis flammea	u	n	r	u

	Common Name	Scientific Name	S	S	F	W
211.	Pine Siskin	Spinus pinus	u	n	u	u
212.	American Goldfinch*	Spinus tristis	a	a	a	c
213.	Red Crossbill	Loxia curvirostra	r	r	r	r
214.	Dickcissel*	Spiza americana	c	c	c	n
215.	Rufous-sided Tohee*	Pipilo erythrophthalmus	u	u	u	n
216.	Savannah Sparrow*	Passerculus sandwichensis	c	c	c	n
217.	Grasshopper Sparrow*	Ammodramus savannarum	u	u	u	n
218.	Henslow's Sparrow*	Ammodramus henslowii	u	u	r	n
219.	Le Conte's Sparrow	Ammospiza leconteis	u	n	u	n
220.	Sharp-tailed Sparrow	Ammospiza caudacuta	u	n	u	n
221.	Vesper Sparrow*	Pooecetes gramineus	c	c	c	n
222.	Lark Sparrow*	Chondestes grammacus	u	u	u	n
223.	Dark-eyed Junco	Junco hyemalis	a	n	a	a
224.	Tree Sparrow	Spizella arborea	c	n	a	a
225.	Chipping Sparrow*	Spizella passerina	a	a	a	n
226.	Clay-colored Sparrow	Spizella pallida	u	o	u	n
227.	Field Sparrow*	Spizella pusilla	c	c	c	r
228.	White-crowned Sparrow	Zonotrichia leucophrys	u-c	n	u-c	r
229.	White-throated Sparrow	Zonotrichia albicollis	c-a	n	c-a	r
230.	Fox Sparrow	Passerella iliaca	c	n	c	n
231.	Lincoln's Sparrow	Melospiza lincolnii	u	n	u	n

Common Name	Scientific Name	S	S	F	W
232. Swamp Sparrow*	Melospiza georgiana	c	c	c	r
233. Song Sparrow*	Melospiza melodia	a	a	a	o
234. Lapland Longspur	Calcarius lapponicus	u	n	u	u
235. Snow Bunting	Plectrophenax nivalis	u	n	u	u

List of mammals known or thought to be present.

	Common Name	Scientific Name
1.	Virginia Opossum	Didelphis marsupialis
2.	Eastern Mole	Scalopus aquaticus
3.	Starnose Mole	Condylura cristata
4.	Masked Shrew	Sorex cinereus
5.	Least Shrew	Cryptotis parrva
6.	Shorttail Shrew	Blarina brevicauda
7.	Little Brown Myotis (Bat)	Myotis lucifugus
8.	Keen Myotis (Bat)	Myotis keeni
9.	Silver-haired Bat	Lasionycteris noctivagans
10.	Eastern Pipistrellus (Bat)	Pipistrellus subflavus
11.	Big Brown Bat	Eptesicus fuscus
12.	Red Bat	Lasiurus borealis
13.	Hoary Bat	Lasiurus cinereus
14.	Raccoon	Procyon lotor
15.	Shorttail Weasel	Musetla erminea
16.	Longtail Weasel	Mustela frenata
17.	Least Weasel	Mustela rixosa
18.	Mink	Mustela vison
19.	River Otter	Lutra canadensis
20.	Badger	Taxidea taxus
21.	Striped Skunk	Mephitis mephitis
22.	Red Fox	Vulpes fulva

	Common Name	Scientific Name
23.	Gray Fox	Urocyon cinereoargenteus
24.	Coyote	Canis latrans
25.	Woodchuck	Marmota monax
26.	Thirteen-lined Ground Squirrel	Spermophilus tridecemlinaetus
27.	Least Chipmunk	Eutamias minimus
28.	Eastern Chipmunk	Tamias striatus
29.	Red Squirrel	Tamiasciurus hudsonicuss
30.	Eastern Gray Squirrel	Sciurus carolinensis
31.	Eastern Fox Squirrel	Sciurus niger
32.	Southern Flying Squirrel	Glaucomys volans
33.	Northern Flying Squirrel	Glaucomys sabrinus
34.	Plains Pocket Gopher	Geomys bursarius
35.	Beaver	Castor canadensis
36.	Western Harvest Mouse	Reithrodontomys megalotis
37.	Deer Mouse	Peromyscus maniculatus
38.	White-footed Mouse	Peromyscus leucopus
39.	Meadow Vole	Microtus pennsylvanicus
40.	Prairie Vole	Pedomys ochrogaster
41.	Pine Vole	Pitymys pinetorumelt
42.	Muskrat	Ondatra zibethica
43.	Norway Rat	Rattus norvegicus
44.	House Mouse	Mus musculus
45.	Meadow Jumping Mouse	Zapus hudsonius
46.	Woodland Jumping Mouse	Napaeo zapus insignis
47.	Eastern Cottontail	Sylvilagus floridanus
48.	White-tailed Deer	Odocoileus virginianus

List of reptiles known or thought to be present.

	Common Name	Scientific Name
1.	Snapping Turtle	Chelydra serpentina
2.	Wood Turtle	Clemmys insculpta
3.	Stinkpot	Sternotherus odoratus
4.	Ornate Box Turtle	Terrapene ornata
5.	Map Turtle	Graptemys geographica
6.	False Map Turtle	Graptemys pseudogeographica
7.	Painted Turtle	Chrysemys picta
8.	Blanding's Turtle	Emydoidea blandingi
9.	Smooth Softshell	Trionyx muticus
10.	Spiny Softshell	Trionyx spiniferous
11.	Five-lined Skink	Eumeces fasciatus
12.	Six-lined Racerunner	Cnemidophorus sexlinaetus
13.	Northern Water Snake	Natrix sipedon
14.	Eastern Garter Snake	Thamnophis sirtalis
15.	Midland Brown Snake	Storeria dekayi wrightorum
16.	Texas Brown Snake	Storeria dekayi texana
17.	Eastern Hognose Snake	Heterodon platyrhinos
18.	Northern Ringneck Snake	Diadophis punctatus
19.	Smooth Green Snake	Opheodrys vernalis
20.	Blue Racer	Coluber constrictor
21.	Bull Snake	Pituophis melanoleucus
22.	Fox Snake	Elaphe vulpina

	Common Name	Scientific Name
23.	Black Rat Snake	Elaphe obsoleta
24.	Eastern Mile Snake	Lampropeltis triangulum
25.	Timber Rattlesnake	Crotalus horridus
26.	Mudpuppy	Necturus maculosus
27.	Central Newt	Notophthalmus viridescens
28.	Eastern Tiger Salamander	Ambystoma tigrinum
29.	Blue-spotted Salamander	Ambystoma laterale
30.	American Toad	Bufo americanus
31.	Spring Peepers	Hyla crucifer
32.	Gray Tree Frog	Hyla versicolor
33.	Western Chorus Frog	Pseudacris triseriata
34.	Blanchard's Cricket Frog	Acris crepitans
35.	Green Frog	Rana clamitans
36.	Bullfrog	Rana catesbeiana
37.	Northern Leopard Frog	Rana pipiens

Hypothetical list of reptiles.

	Common Name	Scientific Name
1.	Prairie Skink	Eumeces septentrionalis
2.	Spotted Salamander	Ambystoma maculatum
3.	Four-toed Salamander	Hemidactylium scutatum
4.	Pickerel Frog	Rana palustris

Endangered or threatened species possibly present.

Endangered Species

Birds

Bald eagle (s)* (f)*
Osprey (s)
American peregrine falcon (migrant) (s) (f)
Arctic peregrine falcon (migrant) (s) (f)
Double-crested cormorant (s)
Harrier (Marsh-hawk) (w)*

Reptiles

Wood turtle (s)

Fish

Speckled chub (w)
Pirate perch (w)
Western sand darter (w)

Threatened Species

Red-shouldered hawk (s)

* s - State protection
f - Federal protection
w - State watch status

United States Department of the Interior

FISH AND WILDLIFE SERVICE

GREEN BAY FIELD OFFICE (ES)

Univ. of Wisconsin—Green Bay

Green Bay, Wisconsin 54302

IN REPLY REFER TO:

GBFO

January 16, 1981

Colonel William W. Badger
District Engineer
U.S. Army Corps of Engineers
St. Paul
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This provides the U.S. Fish and Wildlife Service's Stage 2 planning aid report to accompany your Feasibility Study of alternatives for the Portage Flood Control Project, Columbia County, Wisconsin. As part of the scope of work for Fiscal Year 81, we are providing an analysis of the impacts to fish and wildlife resources of a range of structural and non-structural alternatives being considered to control flooding of the Wisconsin River in the Portage area. Our analysis is based on the flood control alternative information presented in Chapter 5 of the Wisconsin River at Portage Feasibility Study Hydrology and Hydraulics Appendix, dated July 30, 1980. Accordingly, we were as specific as possible based on the information given.

These comments are of a preliminary nature and are submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). They are also consistent with the National Environmental Policy Act of 1969 and Presidential Executive Orders 11988 and 11990 on Floodplain Management and Protection of Wetlands.

STUDY AREA

The main study area is the Wisconsin River floodplain from the Columbia-Sauk County line near the Village of Lewiston, downstream through Portage to the Interstate 90-94 bridge. Also included are portions of Duck Creek and the Baraboo River as affected by Wisconsin River backwater (for approximately 8 miles above the mouth of each), and the Fox River basin as affected by Wisconsin River overflows. The municipalities within the study area generally include the City of Portage and the Townships of Lewiston, Caledonia, Pacific, and Fort Winnebago in Columbia County and the Township of Fairfield in Sauk County (Figure 1). Please reference our February 1, 1980, Stage 1 report for a detailed description of the fish and wildlife resources of the study area.

FISH & WILDLIFE HABITAT - WITHOUT THE PROJECT

Using topographic maps and an aerial photographic mosaic (4 inches to 1 mile), we delineated the primary wetland and upland habitat types occurring in the study area (Figure 2). In November, 1980, we ground truthed and characterized each type to the extent that access would allow. The major habitat types and their associated wildlife species that could be affected by the project are described below. The predominate wetland types are further classified in Table 1.

1. Palustrine Forested Wetland [1/] - bottomland floodplain woods occurring mainly along the Wisconsin and Baraboo Rivers. Prevelent vegetation comprising this habitat type are swamp white oak, silver maple, black willow, river birch, cottonwood, American elm, box elder, and black, green, and white ash. The understory is dominated by a diverse sedge (*Carex* sp.) community. Wildlife known to inhabit or use the floodplain woods at Portage include white-tailed deer, ruffed grouse, woodcock, red-shouldered hawk, osprey, barred owl, numerous songbirds (e.g., red-headed woodpecker, bluejay, kingfisher), raccoon, red and gray squirrel, cottontail, beaver, and river otter.

2. Palustrine Scrub-Shrub Wetland - much of the wetlands adjacent to the Fox River to the north and east of Portage are shrub wetlands. Typical vegetation composing the community are silver maple, red-osier dogwood, cottonwood, tag alder, willow (*Salix* sp.), bluejoint grass, sedges, cattail (*Typha* sp.), and reed canarygrass. The associated wildlife community includes white-tailed deer, woodcock, ruffed grouse, ring-necked pheasant (winter cover), raptors (e.g., red-tailed hawk), cottontail, and several species of small mammals, reptiles, and amphibians.

3. Palustrine Emergent Wetland - a wetland type that is especially abundant along Duck Creek, but is also numerous in the ponds, potholes, and old river oxbows of the study area. The vegetative community includes river bulrush, spikerush (*Eleocharis* sp.), bluejoint, arrowhead (*Sagittaria* sp.), water plantain, phragmites, sedge, and cattail. These wetlands provide excellent waterfowl (e.g., Canada geese, mallard, blue-winged teal) breeding and feeding habitat as well as prime habitat for wading water birds (e.g., great blue and green herons, great egret, American bittern, greater sandhill crane), and furbearers (e.g., muskrat,mink, otter). Emergent wetlands also provide spawning and nursery habitat for fish such as northern pike, perch, and largemouth bass.

[1/] Classification of Wetlands and Deepwater Habitats of the United States. USDI, Fish & Wildlife Service. December, 1979.

Table 1. Classification of the Major Wetland Types in the Portage Study Area

Type	System	Class	Subclass	Water Regime	Dominance Type	Subordinate Types	Primary Location
7	Palustrine	forested wetland	broad-leaved deciduous	semipermanently flooded	swamp-white oak	river birch, ash, silver maple	Wisconsin and Baraboo River floodplains
6	Palustrine	scrub-shrub wetland	broad-leaved deciduous	seasonally flooded or saturated	tag alder	silver maple, red-osier dogwood, willow, reed canarygrass	Fox River floodplain and the Big Slough area
3-5	Palustrine	emergent wetland	persistent	semipermanently flooded	sedges	cattail, river bullrush, blue-joint, phragmites, spikerush	Duck Creek, Long Lake area, the oxbows of the Baraboo and Wisconsin Rivers and most wetlands between STH 51 and the Wisconsin River flood-plain forest
	Lacustrine	unconsol-idated bottom	mud or organic	permanently flooded	*	*	Long, Silver, and Swan Lakes and Lake George
	Riverine	unconsol-idated bottom	sand or mud	permanently flooded (perennial streams)	Diptera	Amphipoda, Gastropoda	Fox River
					Diptera	Trichoptera, Gastropoda	Wisconsin River
					*	*	Baraboo River, Duck and Neenah Creeks

Note - Classification based on USFWS - Wetlands of the United States, Circular 39 and Classification of Wetlands and Deepwater Habitats of the United States

* Dominant and subordinate Orders of macroinvertebrate species unknown

4. Old Field - This type of habitat is especially evident on the Pine Island State Wildlife Area (PISWA) on the south side of the Wisconsin River, just west of State Highway 78. Prairie grass fields are used by ring-necked pheasants, quail, gray partridge, mourning dove, meadowlark, badger, several species of small mammals, and raptors which prey on the small mammals.

5. Oak Forest - Farther west but in the same area of the PISWA, the Old Field habitat grades to Oak Forest. White oaks, river and paper birch are typical along with cedar, sumac, pine plantings, and tag alder shrubs. Ruffed grouse, white-tailed deer, red and gray squirrels and cottontails are some wildlife species that use these forests.

6. Cropland - Corn and alfalfa are the principal crops grown. Ring-necked pheasants, quail and gray partridge are common near intensively cultivated farmlands where shrubs and brushy fence rows are near.

7. Lacustrine Wetland - includes those water bodies such as lakes and ponds greater than 20 acres. Long Lake, Silver Lake, Lake George, and Swan Lake are examples of Lacustrine Wetlands in the study area.

8. Riverine Wetland - includes those wetlands and deepwater habitats within a channel, and are usually flowing water systems. The Wisconsin, Baraboo, Fox Rivers and Neenah and Duck Creeks are Riverine Wetlands in the study area.

Our Stage 1 report described the fish and other aquatic life that inhabit the lakes, rivers, and creeks of the Portage area.

PLANS OF DEVELOPMENT AND IMPACTS - WITH THE PROJECT

I. CHANNEL DIVERSIONS TO BY-PASS PORTAGE

Three diversion channel alternatives are proposed to by-pass floodwater from the Wisconsin River around the City of Portage: a) through Long Lake, b) to the Baraboo River, and c) to the Fox River via Big Slough and Neenah Creek (Figure 3). Two flow conditions for each alternative are presented: The 100-year flood (100 YF) which results in approximately 25,000 cfs spillage, and the Standard Project Flood (SPF) which results in 80,000 cfs spillage. The channel design characteristics proposed to convey water for each flood condition by alternative are listed in Table 2.

The diversion channels would cause several similar environmental consequences.

1. Direct loss of fish and wildlife habitat. The approximate acreages of each habitat that would be directly eliminated between the prospective river basins if connected by a diversion channel are listed in Table 2 for the 100 YF and SPF. The main habitats affected would be Palustrine Forested Wetlands (PFW), P. Emergent Wetlands (PEW), P. Scrub-Shrub Wetlands (PSSW), Croplands (CL), Lacustrine Wetlands (LW), Old Field (OF),

Table 2. Proposed diversion channel designs and acres of each habitat type ..at would be directly eliminated if constructed.

100 Year Flood

	Length (ft.)	Bottom Width (ft.)	Top Width (ft.)	Depth (ft.)	Habitat Type (Acres) PFW	PSSW	PEW	CL	LW	OF	OKF	C	Total Acreage
Long Lake	25,000 4.7 mi.	200	213	20	69				20	17	16		122
Baraboo River	6,000 1.1 mi.	330	339	13	6		2			12	27		47
Fox River (via Big Slough and Neenah Cr.)	20,000	1,000	1,010	15	159	49		137			48	71	464

Standard Project Flood

	Length (ft.)	Bottom Width (ft.)	Top Width (ft.)	Depth (ft.)	Habitat Type (Acres) PFW	PEW	PSSW	LW	OKF	CL	OF	C	Total Acreage
Long Lake	25,000 4.7 mi.	650	663	20	169			81	66		65		381
Baraboo River	6,000 1.1 mi.	1,000	1,009	13	20	6			80		34		140
Fox River (via Big Slough and Neenah Cr.)	20,000 3.8 mi.	2,200	2,210	15	349		107		107		296	156	1,015

Legend

PFW - Palustrine Forested Wetlands
PEW - P. Emergent Wetlands
PSSW - P. Scrub-Shrub Wetlands
LW - Lacustrine Wetlands
OF - Old Field
OKF - Oak Forest
CL - Cropland
C - Drainage Canal

and Oak Forest (OKF). The OF and OKF habitats often grade from one to another and also, both contain pockets of wet marsh meadow.

As shown on Figure 3, the channels would cut through several oxbow ponds and pothole depressions in the Baraboo River and Big Slough area. Further, it appears from the conceptual drawing that Long Lake would be almost completely obliterated. These shallow, open water, emergent marsh areas (PEW and LW) are excellent wildlife habitat, especially for furbearers, waterfowl, and shore and wading birds. Serious and irreparable damage would occur if a channel were excavated through this habitat. Fish and wildlife populations would suffer if floodplain trees and understory vegetation were cleared, oxbow ponds cut off and drained, and bank vegetation removed. Big Slough is a shallow 50-acre slough lake about 5 feet deep and contains an emergent and scrub-shrub wetland perimeter. Fish species reported to move in from Neenah Creek include northern pike, walleye, largemouth bass, bluegill, and black crappie. The emergent vegetation around the perimeter provides excellent northern pike spawning habitat when flooded in the spring. The area of Big Slough where the proposed diversion channel would enter is a designated game farm licensed by the Wisconsin Department of Natural Resources (WDNR). Long Lake is a 65-acre oxbow lake about 20 feet deep. Its wetland characteristics and fishery are nearly the same as Big Slough except that the shoreline perimeter contains more scrub-shrub and forested wetlands than emergent wetlands. Both water bodies are also excellent areas for waterfowl and shorebirds.

The magnitude of habitat losses is placed even more in perspective when the hydraulic nature of the channel is considered. Since the channel design depth would approximate low flow conditions for the rivers being connected, it is likely that the hydraulic gradient would effectively drain wetlands along the length of the diversion channel. Therefore, several hundred more acres of PEW, PFW, PSSW, and LW could be drained if a diversion channel alternative were developed.

2. Interruption of wildlife movements. Another concern with long steep sloped channels is that they could interfere with local wildlife movements or trap wildlife within. For instance, in the West several cases have been reported of deer drowning in water conveyance canals or dying from stress and fatigue. The side slopes may become lined with algae and be too slippery to ascend. Impassable fencing and sod-covered cross points have helped to mitigate wildlife mortality and reduce impedance to movements. In the Portage area, white-tailed deer would perhaps be the greatest species of concern in this impact category.

3. Sedimentation. Habitat losses from sediment could result from a diversion channel both in the short term during construction and over the long term from sediment translocation from the Wisconsin River basin. Sediment would build up in the diversion channel and also be flushed into the receiving river or slough. Wetlands and open water habitat would be filled and their use to fish for spawning and nursery activities or their

use to waterbirds for nesting, resting, and feeding would be lost or degraded. The slack pools in the Big Slough area would be especially susceptable to being filled.

4. Impact on Environmentally Sensitive Areas.

a. Pine Island State Wildlife Area. The Long Lake and Baraboo River channels would transverse portions of the PISWA. Concurrence from the WDNR is, of course, a paramount issue. In our opinion, this would be an undesirable and incompatible use of a public recreation area. Game habitat would be degraded, game management would be impaired or complicated and hunting or other recreational use of the area would be interrupted. Note that this area is not strictly a wildlife area, rather it is classified as "multi-recreational use."

b. Baraboo River Floodplain Forest (T12N, R9E, Section 20, 21, 28 and 29). Five hundred and twenty acres of privately owned floodplain forest near the confluence of the Baraboo and Wisconsin Rivers, Caledonia Township, are classified by the WDNR as a Natural Area of Statewide Significance. Red-shouldered hawks (*Buteo lineatus*), a State Threatened species, nest there. The Long Lake channel would almost completely bisect this natural area and destroy prime red-shouldered hawk nesting forest.

c. Greater Sandhill Crane Nesting Habitat. Our bird survey information indicates that several breeding pairs of greater sandhill crane nest in Caledonia and Lewiston Townships, some of which are in close proximity to the proposed diversion channels. Greater sandhill cranes are an important migratory wading bird that was on the Federal List of Rare and Endangered Species. Although it was removed from the list in 1973, marsh grass meadows play an important role in the continued recovery and stabilization of the population. Direct elimination of habitat by channel construction coupled with the potential for wetland drainage along the length of the channel would eliminate or degrade important sandhill crane nesting habitat and force some breeding pairs out. Wetland drainage is one of the biggest threats to the sandhill cranes in Wisconsin.

II. CHANNEL MODIFICATIONS

a. Caledonia Levee Outlet. Another proposed solution to eliminate overflow into Lewiston and Pacific Townships is to construct a 500 foot long outlet in the Caledonia Levee on the south side of the Wisconsin River, about .75 miles west of STH 78 (Figure 3). The PISWA would serve as a lateral reservoir (Caledonia Reservoir) to accommodate the excess 25,000 cfs for the 100 YF and 80,000 cfs for the SPF. However, as stated on Page 5-3, this alternative is not hydraulically feasible without increasing the floodwater storage capability of the PISWA. Levees would have to be constructed around the PISWA at a height adequate to contain a 7-foot depth for the 100 YF and a 10-foot depth for the SPF.

Again concurrence with the WDNR would be one of the first issues to resolve because such a measure may not be compatible with their wildlife management or other recreational objectives. From an environmental point of view, the idea may have merit. The PISWA behind (south) of the Caledonia Levee is primarily upland habitat and at present is protected from most high water conditions of the Wisconsin River. To breach the levee where proposed would cause mainly Old Field and Oak Forest to be flooded. To predict with any certainty the site specific impacts would require that the frequency, depth and duration of inundation be known and also the plant species tolerance to inundation and water level changes. However, it seems fair to surmise that if the area flooded only occasionally, in other words, not every year, the vegetative community could likely tolerate the temporary change. If this were the case, the environmental impacts should be minor, and mostly temporary. The levees could be routed around wetlands as much as possible to further reduce adverse impacts. Some type of outlet structure in the levee would probably be needed to control water entry into the PISWA.

b. Clearing and Snagging. The extensive clearing of approximately 8 miles of the Wisconsin River channel and overbank areas of debris, brush, and trees is a channel modification alternative proposed to increase the river's capacity to convey water and decrease local flooding (Figure 3). A large scale clearing and snagging operation would be highly destructive to the flora and fauna of the river. Many of the effects are obvious, while others are more subtle. From a wildlife viewpoint, bottomland floodplain forests are a highly valuable habitat type due to their capability to support a rich diversity of wildlife species. As shown in the previous description of this habitat type, many popular animals sought after by hunters or otherwise wildlife orientated enthusiasts are found there. Other animals not so popular still perform an important role in the balance of the wildlife community. An extensive clearing project would eliminate hundreds of acres of prime floodplain forest (PFW) and the associated wildlife community. Because bottomlands are being cleared at an alarming rate throughout the country, the Service classifies their loss as a nationally Important Resource Problem (IRP).

Snagging and clearing in and along the river would also have significant adverse aquatic impacts, beginning low in the trophic structure. For example, clearing many broad-leaved trees would reduce the input of leaves and other organic detritus into the water. Several aquatic macroinvertebrates, such as certain species of caddis, crane, and stone fly larvae, ingest and breakdown the coarse particulate organic matter for food. Also, these creatures depend on log jams and brushpiles for stable substrate to inhabit rather than the unstable shifting sandy river bottom. Eliminating the macroinvertebrates' food and substrate over several miles of river would reduce the local population. Further, most river fish use invertebrates as a food source and would then no longer have that option readily available. We recognize, however, that some organisms would be replaced by invertebrate drift. From another perspective, it is well known that many fish such as largemouth bass, walleye, crappie, and catfish

congregate near the cover, food, and shelter from the current that stumpfields and brushfields provide. Accordingly, removing this habitat would have serious irreparable adverse fishery impacts.

c. Dredging. Two dredging schemes are proposed: Construct a trapezoidal channel (3:1 slopes, bottom width of 1,500 ft.) for approximately 8 miles within the Wisconsin River channel from points A to B, or widen and deepen the river between points A and B (Figure 3). Both plans have several adverse environmental effects in common, the most obvious being the conversion by channelization, of a natural river to an artificial water conveyance facility. The destructive biological effects of channelization are well documented in the literature and we do not believe a thorough dissertation on the subject is warranted in this report. We will, however, list the major categories of impacts as they pertain to the fish and wildlife habitat types characteristic of the Portage area.

1. River meanders would be made more uniform and most aquatic habitat diversity such as deep holes, brushpiles, stumpfields, aquatic plant beds, and shallow bays would be eliminated. Habitat diversity functionally and spacially separate groups of fishes and other aquatic life. To eliminate these "nitches" would result in reduced species diversity and bring about a more monotypic community, a typical undesirable effect of channelization.

2. Dredging to widen and deepen the river would likely adversely effect the speckled chub (Hybopsis aestivalis), a State Threatened species. Becker and Myrah (1969) collected this fish approximately .5 mile downstream from the STH 78 bridge. This species primarily inhabits large rivers and mainly in fast water over broad shallow sandy riffles. Another State Threatened fish species that would likely suffer is the black buffalo (Ictiobus niger). It has been reported in the study area but mainly occurs downstream of Portage in the Lake Wisconsin area. The species inhabits sloughs, backwaters and impoundments and is also found in strong currents where the channel narrows.

3. Timbered islands would have to be cleared and a channel dredged through them. Also, several unvegetated sand and mud flats would be removed. Excellent resting habitat for waterfowl, wading waterbirds, and shorebirds would be eliminated.

4. The floodplain could change drastically if the river bed was lowered to contain both normal and flood flows. For example, the abundant floodplain forests (PFW) which now line the Wisconsin River at Portage would no longer get a frequent surge of water and nutrients that floods provide to floodplains. To curtail spillage would make the forests drier and eventually a vegetative change accompanied by a shift in the associated wildlife community could occur. Of equal concern is the significant secondary impacts that could result. If the threat of flooding were removed, floodplain development regulations could change and the bottomlands would become susceptible to clearing for development.

We realize that this would not likely happen on the public lands in the study area, but hundreds of acres of private bottomland would still be in jeopardy. In our opinion, to select a plan that would allow this would be in direct conflict with Executive Orders 11988 on Floodplain Management and 11990 Protection of Wetlands.

5. Approximately 1.9 x 10^6 cubic yards of sediment would have to be removed to lower the riverbed about 2 feet. Finding environmentally acceptable disposal sites to accommodate the large volume of material could be a serious problem. Our policy on disposal is in an upland site out of the 100-year floodplain and exclusive of wetlands, and other sensitive wildlife habitat. The material would, however, contain a lot of sand which could possibly be stockpiled and used for a beneficial purpose such as sand for roads or fill at building sites. Another problem is that frequent maintenance dredging would have to be conducted to keep the channel functional. The disposal problem would be reoccurring. Also, frequent dredging would roil the bottom and greatly hamper a biological community from becoming stabilized.

III. LEVEE IMPROVEMENT

Several miles of levees have been built along the Wisconsin River in the Portage Area since the late 1800s (Figures 1 and 3). The Portage Levee extends through the city and to the southeast, the Lewiston Levee runs west of the city along the left bank and the Caledonia Levee runs east-west on the south side of the river. Undoubtedly, the environmental characteristics of the floodplain have been profoundly affected by the levees. One obvious change is that the lowland between the levees and the river have remained almost completely undeveloped while development has proceeded on the other levee side where some measure of flood protection was present.

The floodplain forests and other wetlands between the Wisconsin River and levees are prime fish and wildlife habitat. The resource values have been previously discussed and accordingly, the primary environmental objective of any levee system proposed should be to minimize to the greatest extent possible damage to the Wisconsin River and its associated floodplain environment. Three levee improvement plans being considered are shown below.

	100 YF		SPF	
	Length (ft)	Height (ft)	Length (ft)	Height (ft)
a. Portage	21,000 (4 mi.)	6	21,000	8
b. Left bank only	58,000 (11 mi.)	6	58,000	8
c. All	115,000 (22 mi.)	6	115,000	8

We understand that new levees could not be built on the existing ones because they do not meet the Corps of Engineer's design standards. Accordingly, either the existing levees would have to be removed or a new alignment selected, both of which would result in more environmental disturbance than adding to the existing ones. As far as we know, the exact alignments for the three above levee options have not been proposed. In any plan, the positioning of the levees would be critical to preserving floodplain forest and other wetland habitat in the Portage area. For example, moving the levee alignment closer to the Wisconsin River would be highly undesirable. Clearing, filling and building in the floodplain, which would then be flood proofed, would undoubtedly occur up to the new levee. Hundreds of acres of wetlands could be lost in that manner and in our opinion, a plan of this type would contravene Executive Orders 11990 and 11988. We therefore, wish to be involved in the detailed planning of all proposed levee alignments.

The 11 miles of levee improvements proposed for the Left Bank Only option (Lewiston and Portage Levees) or 22 miles of levee improvements for the All (includes the Caledonia Levee) proposal would involve a much greater portion of the study area, and hence greater environmental disturbance, than the 4 miles proposed for the Portage Only alternative. According to your Standard Project Flood map, the majority of lands that flood besides residential Portage include the Pine Island and Swan Lake State Wildlife Areas (much of which is wetland), farmland, roads, and relatively undeveloped floodplain forests and shrub wetlands adjacent to the Wisconsin, Baraboo, and Fox Rivers. In our opinion, to construct several miles of levees to flood proof these lands is unnecessary and not worth the economic and environmental costs. These areas usually recover relatively quickly from occasional inundation and do not suffer the major damage that occurs to residential property. The environmental costs or effects of a large scale levee project include loss of floodplain wildlife habitat by larger levees designed to contain the SPF; loss of habitat by levee access roads during construction, and perhaps the most significant long term effect; displacement of wildlife habitat as development encroaches into the floodplain that would be flood proofed. Accordingly, we believe that with proper planning the "improvement of the Portage Levee only" proposal may be the best solution to alleviate flooding to the majority of residential Portage at comparatively low costs and still maintain a high degree of environmental protection for the abundant floodplain forests and other wetlands that abut the city. Our suggested levee plan for your detailed analysis in Stage 3 is as follows (Figure 4):

1. Align the new levee to closely approximate the Corps' permit jurisdiction line for the Fox and Wisconsin Rivers as regulated under Section 404 of the Clean Water Act of 1977 and Section 10 of the Rivers and Harbors Act of 1899 (see Figure 4 for FWS interpretation).

2. On the east side of the city, begin the levee at the junction of STH 51 and Ontario Street; extend it northeast along Ontario Street (just east of the houses) to the Chicago, Milwaukee and St. Paul Railroad tracks; continue northwest along the tracks to Wauona Trail Road and lastly, follow the road northeast to a point where the levee could tie

into STH 33. Highway 33 would have to be elevated approximately 5 feet in the Fox River area for 100 YF protection and obviously elevated more for SPF protection. Much of the land adjacent to the Fox River just northwest of STH 33 between Hamilton Street and the Portage Canal is wetland; this area should not be flood proofed by levees.

3. Flood proof or evacuate the few scattered dwellings east of our proposed Ontario St. Levee alignment that would not have flood protection.

4. On the south side of the city through town, align the levee as close as possible to the existing Portage Levee.

5. On the west side, follow the natural upland bluff line south of the houses along west Conant St. to Summit St. then to River St.; continue northwest riverward of the houses and end approximately at the STH 78 overpass. The topography is higher in this area and thus a levee may not be needed in some areas.

In our opinion, this plan is economically desirable as well as environmentally favorable because it "conceptually" provides flood protection to the majority of the residential city with a minimal amount of new levees required. We realize the plan would have to be analyzed for all appropriate flood control criteria.

IV. NEW UPSTREAM RESERVOIRS AND FLOOD STORAGE MODIFICATIONS TO EXISTING POOLS

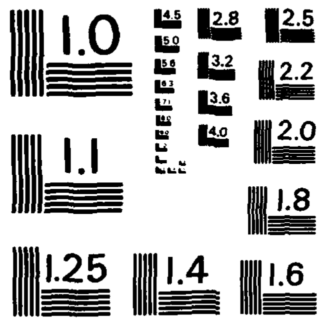
The proposed alternatives of creating new upstream reservoirs, increasing the flood storage at existing dams, lowering the operating pool of upstream dams, raising structure heights of upstream dams, and modifying operation of the Prairie Du Sac Dam Spillways are handled briefly in Chapter 5. In each case, it is concluded that the increased storage capacity would not increase the flood control storage sufficiently to reduce the 100 YF discharge on the Wisconsin River below the minimum spill discharge of approximately 60,000 cfs.

Upstream Reservoirs - Dams can either benefit fish and wildlife or destroy them. Most assuredly, impounding a stream would cause many dramatic changes. Wildlife habitat would be permanently lost by flooding, including the valuable riparian corridor along the stream. The ecology of running water would shift to more of a lake type environment, which means changes in the flora and fauna communities as some species adapt and others expire. The stream fishery would be converted to a reservoir type which could force undesirable changes in the community structure. For exampe, if a trout stream were impounded much of it would likely become unsuitable for trout habitat because of the elevated temperature regime in the pool and discharge water.

Therefore, because of the significant environmental impacts associated with new upstream reservoirs on subwatersheds of the Wisconsin River, very close multiagency coordination would be required to determine whether or not dam(s) as a solution to flooding would best serve the public interest.

AD-A148 351 FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT WISCONSIN RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 83 7/9

UNCLASSIFIED F/G 13/2 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

Modifications to Existing Upstream Dams and Reservoirs to Increase Flood Storage -

A significant impact of 1) raising the height of existing upstream dams, 2) lowering the operating pool of reservoirs, or 3) modifying the operation of the Prairie Du Sac Dam Spillways is that pronounced changes would occur in pool water levels and probably in seasonal fluctuation patterns. Again, fish and wildlife can benefit from reservoir fluctuation or be adversely effected by it. Timing in accordance with biological activities is perhaps the most critical factor. Pool fluctuation could generally benefit fish and wildlife if higher water levels occurred in the spring to maximize fish spawning habitat in the littoral zone of the flowage. Also, waterfowl would be forced to nest above high water consequently, nest losses from flooding would be either avoided or minimized. Higher fall water levels would inundate more aquatic vegetation and provide additional feeding and nesting areas for migrating waterfowl.

On the other hand, water levels that have a rapid daily fluctuation and extreme or erratic seasonal fluctuation are usually detrimental to fish and wildlife unless this measure is being used as a management technique to control nuisance species. Drawdowns at the wrong time of the season can cause such adverse environmental effects as leaving fish spawning areas high and dry and dewatering shoreline wetlands when migratory birds need them.

In summary, we would need more information before we could determine how the proposed modifications to existing upstream reservoirs would affect fish and wildlife resources. If the proposed reservoir modifications are pursued further as flood control measures, an environmental study of the reservoirs proposed for change would be the most appropriate and scientific course of action to determine lake specific impacts, especially which communities would benefit and which would not.

V. NON-STRUCTURAL SOLUTIONS

Non-structural solutions to flooding problems might include:

Floodplain Evacuation - Undoubtedly, there are situations where the public benefit of preserving high quality floodplain habitat would outweigh the costs of evacuation.

Floodproofing - It may not be practical to evacuate some structures located in the floodplain because of excessive costs. In these cases, flood proofing should be seriously evaluated as an alternative to an expensive and environmentally destructive structural solution, particularly where only a few sporadic structures need flood protection.

Floodplain Zoning - In our opinion, good floodplain zoning protects the environmental characteristics of the floodplain and also prevents the loss of life and property. A workable plan must be regulated, enforceable, and well understood by the public so a prospective developer can find out where it is safe to build. Floodplain zoning is especially valuable when flood prone cities like Portage are planning what direction/s the city should expand.

We believe non-structural solutions to flooding problems have historically been under emphasized and consequently, much unnecessary environmental damge to floodplains by structural measures have resulted. Non-structural solutions may be workable in certain geographic areas of the floodplain and therefore could comprise part of a combination of measures plan when the final comprehensive flood control plan for Portage is developed.

ENVIRONMENTALLY SENSITIVE AREAS

We consider the following resource areas as environmentally sensitive and should receive special consideration in plan development: the Pine Island and Swan Lake State Wildlife Areas, Baraboo River Floodplain Forest (Natural Area of Statewide Significance), greater sandhill crane nesting habitat, red-shouldered hawk nesting habitat (State Threatened species), speckled chub and black buffalo habitat (State Threatened fish species), and the Leopold Memorial Reserve (National Historic Landmark). The values of each area have been previously described either in this report or our Stage 1 report.

Table 3 rates our judgement of the magnitude of impact that each alternative would have on the above mentioned special resource areas. We listed an Ia (inadequate information) for those alternatives where project data was not sufficient to evaluate an impact rating. However, Stage 3 studies will allow us to refine more definitively probable impacts to each environmentally sensitive area.

ENDANGERED AND THREATENED SPECIES

To comply with Section 7 of the Endangered Species Act of 1973, as amended, you should contact the Area Manager, FWS, Region 3, Twin Cities Area Office, St. Paul, Minnesota to 1) obtain a list of federally endangered or threatened species that my occur in the study area 2) obtain information relative to your possible need to conduct a biological assessment of potential project caused impacts upon those species listed.

Specially designated species on the _State_ endangered or threatened list known to occur in the study area are:

Birds

Endangered
double-crested cormorant (_Phalacrocorax auritus_)
bald eagle (_Haliaeetus leucocephalus_)
osprey (_Pandion haliaetus_)
peregrine falcon (_Falco peregrinus_)
common tern (_Sterna hirundo_)
Forester's tern (_Sterna forsteri_)

Table 3. Impact rating for each proposed alternative on known environmentally sensitive areas in the Portage study area.

	PISWA	SLSWA	NASWS	GSCNH	RSHNK	STF	LMR
DIVERSION CHANNELS							
Long Lake	Ma	Mi	Ma	Mo	Ma	Mo	Mi
Baraboo River	Ma	Mi	Mo	Ma	Ma	Mo	Mi
Fox River via Big Slough	Mi	Mi	Mi	Ma	Mo	Mo	Mi
CHANNEL MODIFICATIONS							
Caledonia Levee Outlet	Mo	Mi	Mi	Mi	Mi	Mi	Mi
Snagging and Clearing	Ma	Mi	Ma	Ma	Ma	Ma	Mi
Dredging	Ma	Mi	Ma	Mo	Ma	Ma	Mi
LEVEE IMPROVEMENT							
Portage Levee only (FWS proposed alternative)	Mi	Mi	Mi	Mi	Mi	Mi	Mi
Along the left bank only--Ia*							
All levees--Ia							
NEW RESERVOIRS--Ia							
INCREASED STORAGE OF EXISTING DAMS--Ia							

NON-STRUCTURAL MEASURES - Presumed minor for all areas but specific proposal must be known.

Legend
PISWA - Pine Island State Wildlife Area
SLSWA - Swan Lake State Wildlife Area
NASWS - Natural Area of State Wide Significance
GSCNH - Greater Sandhill Crane Nesting Habitat
RSHNK - Red-shouldered hawk nesting habitat (State Threatened Species)
STF - State Threatened Fish - Wisconsin River (speckled chub, black buffalo)
LMR - Leopold Memorial Reserve

Impact Rating
Ma - Major, mitigation not practical (irreversible)
Mo - Moderate, mitigation possible (reversible)
Mi - Minor or no appreciable impact - mitigation attainable (reversible)
Ia - Inadequate information to evaluate impacts

* Proposed levee alignments unknown

Threatened
Cooper's hawk (Accipiter cooperii)
great egret (Casmerodius albus)
red-shouldered hawk (Buteo lineatus) - nests in the study area

Fish - Wisconsin River

Threatened
speckled chub (Hybopsis aestivalis)
black buffalo (Ictiobus niger)

Species of major concern known to inhabit the study area are the red-shouldered hawk, speckled chub, and black buffalo. The hawk nests in floodplain woods. The chub inhabits the Wisconsin River in areas where fast current flows over sandy shoals, and the buffalo is found in the sloughs and backwaters of the river.

According to our information, the other bird species listed as having special state status are not known to nest in the study area. However, you should contact the WDNR Office of Endangered Species in Madison, Wisconsin to benefit from their flora and fauna survey information and also their comments on project caused impacts.

CONCLUSIONS AND RECOMMENDATIONS

1. All three diversion channels, the snagging and clearing alternative, and both dredging proposals would cause severe damage to fish and wildlife resources and be unavoidable and not practical to mitigate. If these alternatives are pursued, the Service would likely oppose them. However, a limited snagging and clearing or dredging proposal as part of a comprehensive flood control plan would warrant our further consideration. For those alternatives that consider new upstream reservoirs or modifications of existing reservoir operations, we would need more information to evaluate site specific impacts.

2. The FWS proposed levee alignment plan for the Portage Levee Only alternative, or a mutually agreeable modification of it, should be evaluated in detail during Stage 3 studies.

3. The Wisconsin Department of Natural Resources (WDNR), Bureau of Environmental Impact, should review the proposed flood control alternatives before Stage 3 studies begin. Their comments would be especially helpful pertaining to which alternatives from a State regulatory viewpoint could or would not be permitted.

4. Utilizing the Pine Island State Wildlife Area as a temporary flood storage area by breaching the Caledonia Levee Outlet may have merit, assuming the WDNR concurs.

5. To comply with Section 7 of the Endangered Species Act of 1973, as amended, initiate informal consultation by contacting the Area Manager. For information pertaining to State endangered and threatened species statutes contact the WDNR Office of Endangered Species.

6. All alternatives proposed for Stage 3 study should avoid through early planning the Leopold Memorial Reserve. The Service would likely oppose any plan that would physically modify or otherwise degrade this Reserve. Aldo Leopold's "shack" is a National Historic Landmark. The Reserve is underwritten by L.R. Head Foundation, 201 Waubesa Street, Madison, WI 53704 and we suggest you keep the Foundation informed on the status of the study.

7. Floodplain evacuation, zoning, and flood proofing should be evaluated in Stage 3 as part of a comprehensive flood control plan and applied in those areas of the floodplain where structural costs and/or environmental damage can be reduced.

We hope this report and our other previous correspondence (April 1, 1977, May 5, 1977, and February 1, 1979) will help your analysis of feasible flood control alternatives and we look forward to further input during Stage 3 to help you develop an environmentally acceptable plan.

Sincerely yours,

Ronald G. Spry

Ronald G. Spry
Acting Field Supervisor

cc: DuWayne Gebken, DNR, Madison, WI
U.S. EPA, Chicago, IL

REFERENCES

Becker, Dale & Gordon Myrah. 1969. Fish Collections in the Wisconsin River Between the Cities of Lake Delton and Portage. Unpublished Report, University of Wisconsin-Stevens Point.

Bennett, James A. 1978. Ecology and Status of Greater Sandhill Cranes in Southeastern Wisconsin. Unpublished M.S. Thesis. May.

The Wisconsin Society for Ornithology, Inc., 1976. Wisconsin Favorite Bird Haunts.

U.S. Army Corps of Engineers, St. Paul District. 1980. Wisconsin River at Portage Feasibility Study Hydrology and Hydraulics Appendix DACW37-78-C-0175. July.

U.S. Environmental Protection Agency, 1978. Biological Study of the Fox and Wisconsin Rivers. Unpublished report. October.

U.S. Fish and Wildlife Service, Office of Biological Services. 1980. A Handbook for Terrestrial Habitat Evaluation in Central Missouri.

_____. 1980. Riparian Ecosystems: A Preliminary Assessment of Their Importance, Status, and Needs.

_____. 1979. Classification of Wetlands and Deepwater Habitats of the United States.

_____. 1978. The Potential Effects of Clearing and Snagging on Stream Ecosystems.

_____. 1978. Western Stream Habitat Improvements Handbook.

_____. 1956. Wetlands of the United States, Circular 39.

Wisconsin Department of Natural Resources. 1980. Draft Environmental Impact Statement for the Wastewater Treatment Facilities, City of Portage, Wisconsin.

_____. 1979. Natural Areas of Statewide Significance. Unpublished report. November 30.

_____. 1979. The Vanishing Wild.

_____. 1976. Public Hunting Areas. Map.

_____. 1977. Endangered Species Program, Progress Report, 1975-76. Unpublished report.

_____. 1974. Seasonal Movement, Winter Habitat Use, and Population Distribution of an East Central Wisconsin Pheasant Population; Tech. Bull. 76.

_____. Wisconsin Lakes. 1974. Publication 7-3600(74)

_____. 1973. Final Environmental Impact Statement, Columbia Generating Station, Wisconsin Power and Light Company.

_____. 1973. Gray Partridge Ecology in Southeast-Central Wisconsin; Tech. Bull. 70.

_____. 1972. Birds of Prey of Wisconsin.

_____. 1971. Wisconsin Walleye Waters. Pub. 241-71.

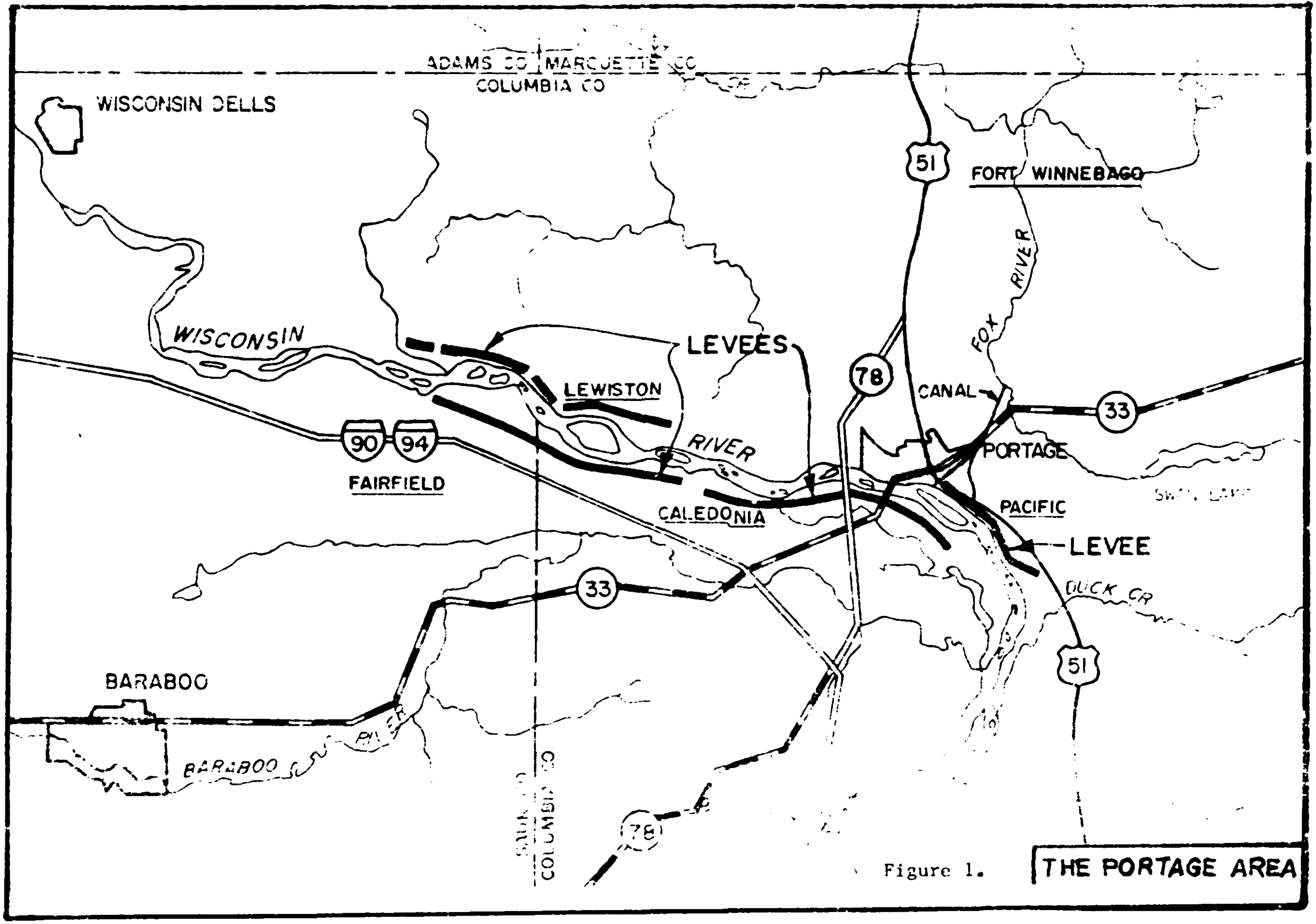
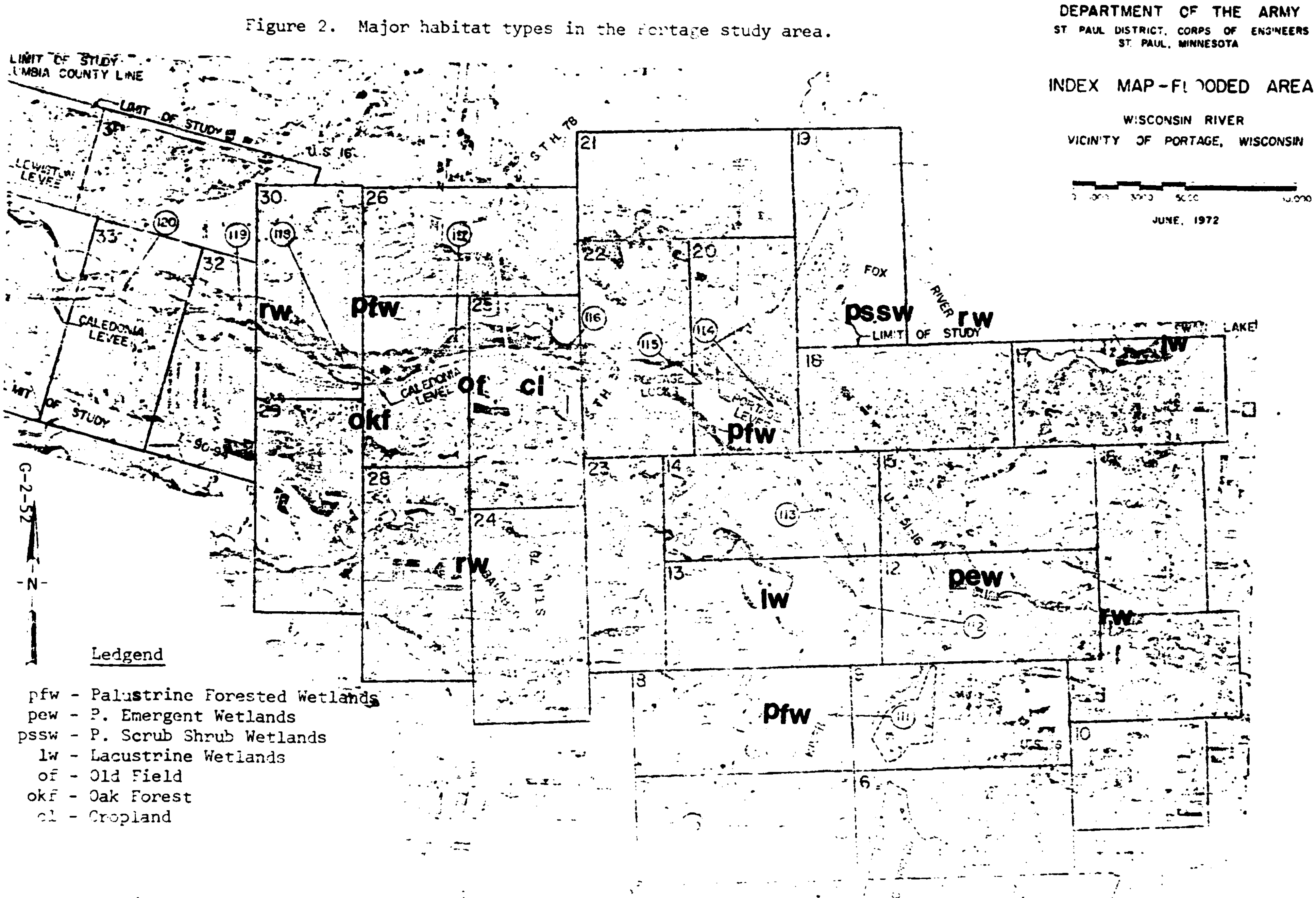

THE PORTAGE AREA
ADAMS CO
MARQUETTE CO
COLUMBIA CO
WISCONSIN DELLS
51
FORT WINNEBAGO
FOX RIVER
WISCONSIN
LEVEES
LEWISTON
RIVER
78
CANAL
33
PORTAGE
90
94
FAIRFIELD
CALEDONIA
PACIFIC
LEVEE
DUCK CR
BARABOO
BARABOO
RIVER
COLUMBIA CO

Figure 1.

Figure 2. Major habitat types in the Portage study area.



Ledgend

pfw - Palustrine Forested Wetlands
pew - P. Emergent Wetlands
pssw - P. Scrub Shrub Wetlands
lw - Lacustrine Wetlands
of - Old Field
okf - Oak Forest
cl - Cropland

G-2-52

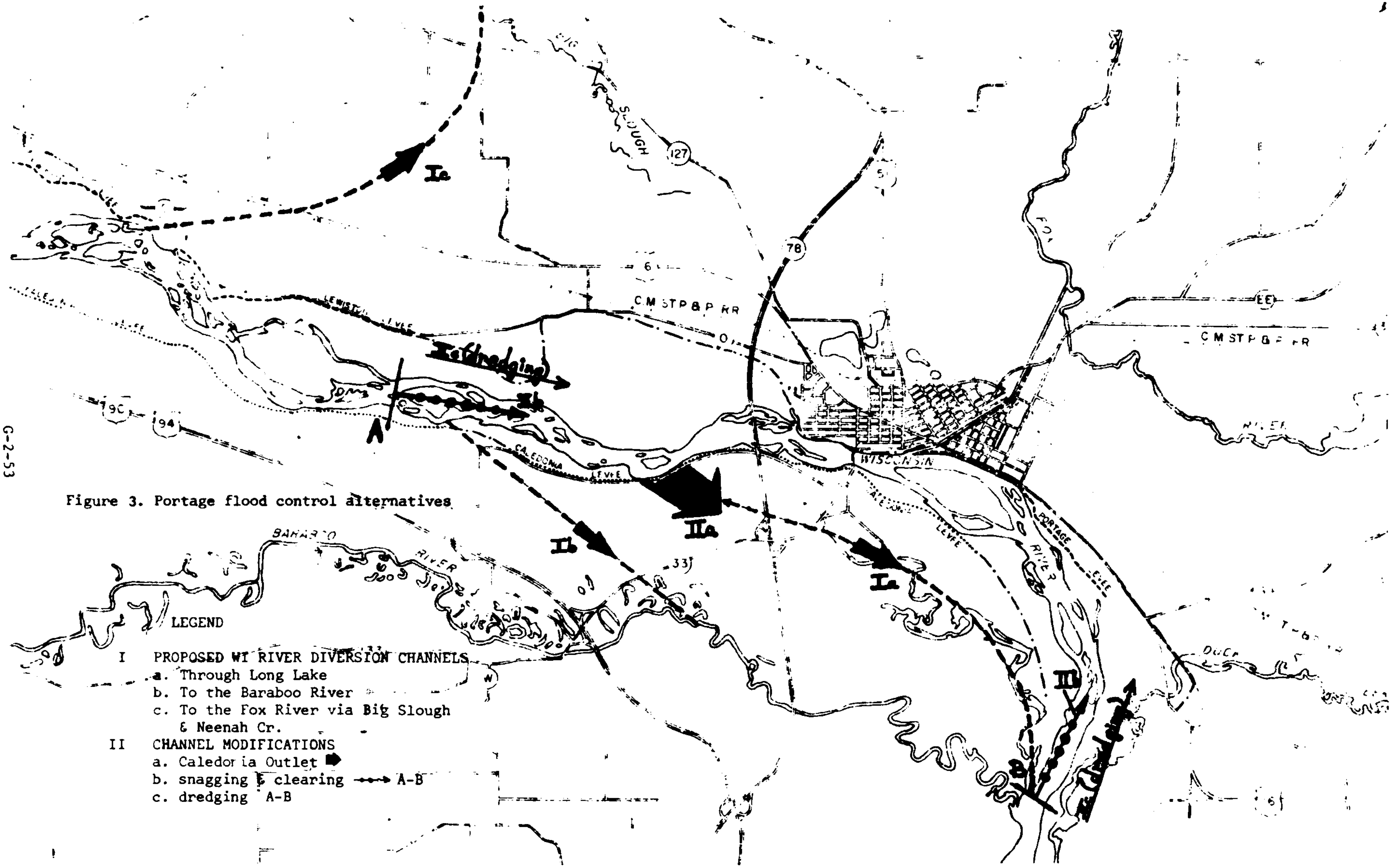
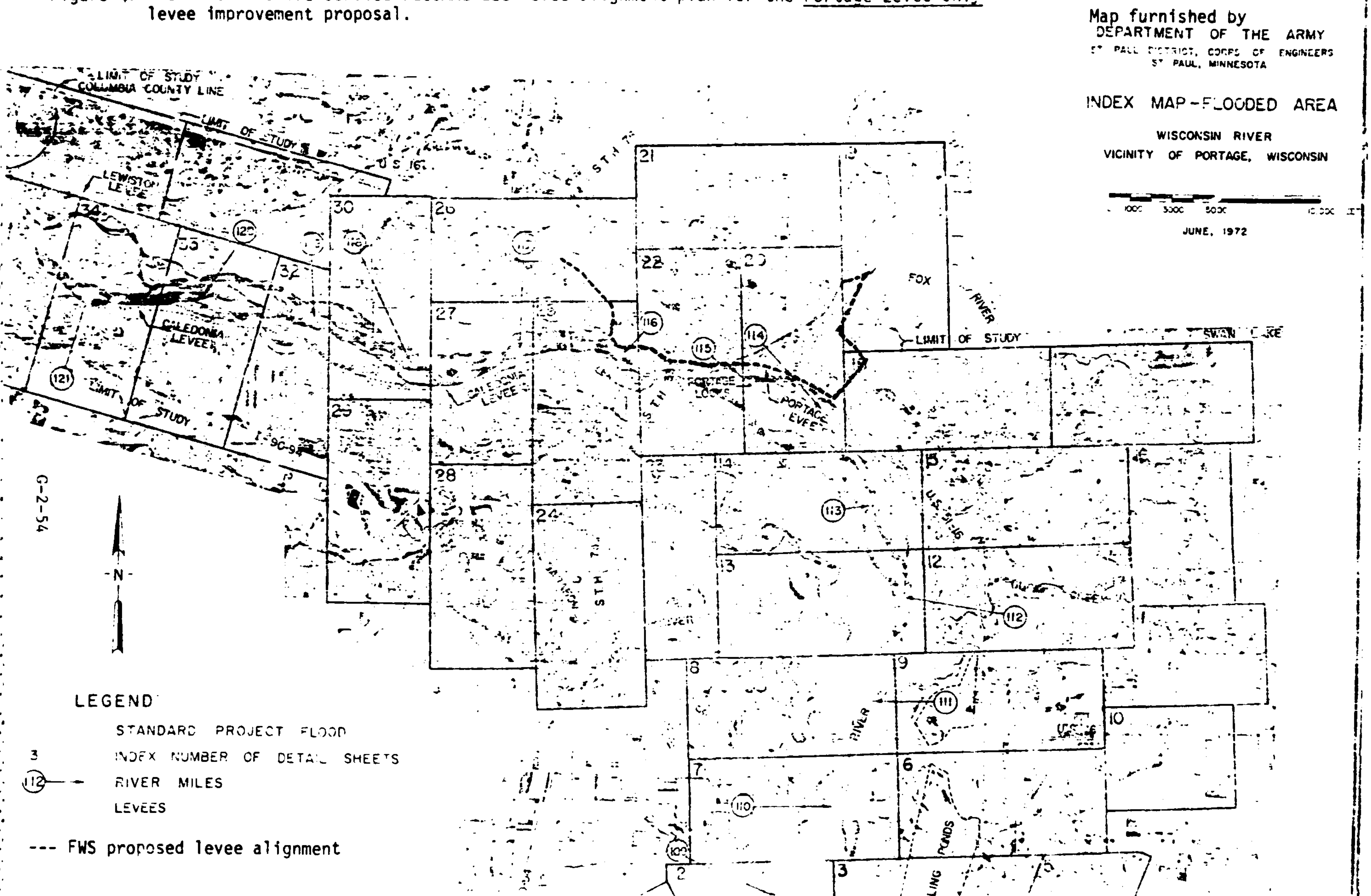


Figure 3. Portage flood control alternatives

Figure 4. Fish and Wildlife Service recommended levee alignment plan for the Portage Levee Only levee improvement proposal.



United States Department of the Interior

FISH AND WILDLIFE SERVICE
TWIN CITIES AREA OFFICE
530 Federal Building and US Court House
316 North Robert Street
St. Paul, Minnesota 55101

IN REPLY REFER TO:

Colonel William W. Badger
District Engineer
U.S. Army Corps of Engineers
St. Paul
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

In accordance with our scope of work for Fiscal Year 1982, this provides the U.S. Fish and Wildlife Service's (FWS) Stage 3 report to accompany your draft Feasibility Report for Stage 3 studies on the Portage Flood Control Project, Columbia County, Wisconsin. Recognize that it may be necessary to supplement this report prior to inclusion in your final Feasibility Report if, in the interim, new information becomes available or if significant changes occur in project design(s).

This report is submitted in accordance with the requirements of the Fish & Wildlife Coordination Act (48 Stat. 401, as amended 16 U.S.C. 661 et seq.). They are also consistent with the National Environmental Policy Act of 1969 and Presidential Executive Orders 11988 and 11990 on Floodplain Management and Protection of Wetlands.

STUDY AREA

The main study area is the Wisconsin River floodplain from the Columbia-Sauk County line near the village of Lewiston, downstream through Portage to the Interstate 90-94 bridge. Also included are portions of Duck Creek and the Baraboo River as affected by Wisconsin River backwater (for approximately 8 miles above the mouth of each), and the Fox River basin as affected by Wisconsin River overflows. The municipalities within the study area generally include the city of Portage and the townships of Lewiston, Caledonia, Pacific, and Fort Winnebago in Columbia County and the township of Fairfield in Sauk County (Figure 1). Please reference our Stage I and II reports dated February 1, 1979 and January 16, 1981, respectively, for detailed descriptions of the fish and wildlife resources of the project area and also for the general impacts upon those resources of a range of other flood control alternatives considered at Portage to date.

FISH & WILDLIFE HABITAT - WITHOUT THE PROJECT

ur Stage II report described the primary habitat types and associated fish and wildlife species that could be affected by the various project alternatives. Since we will be referring to them frequently, they are listed below and further classified in Table 1.

1. Palustrine Forested Wetland[1/] - bottomland floodplain woods occurring mainly along the Wisconsin and Baraboo Rivers. Prevelent vegetation comprising this habitat type are swamp white oak, silver maple, black willow, river birch, cottonwood, American elm, box elder, and black, green, and white ash. The understory is dominated by a diverse sedge (*Carex* sp.) community. Wildlife known to inhabit or use the floodplain woods at Portage include white-tailed deer, ruffed grouse, woodcock, red-shouldered hawk, osprey, barred owl, numerous songbirds (e.g., red-headed woodpecker, bluejay, kingfisher), raccoon, red and gray squirrel, cottontail, beaver, and river otter.

2. Palustrine Scrub-Shrub Wetland - much of the wetlands adjacent to the Fox River to the north and east of Portage are shrub wetlands. Typical vegetation composing the community are silver maple, red-osier dogwood, cottonwood, tag alder, willow (*Salix* sp.), and reed canarygrass. The associated wildlife community includes white-tailed deer, woodcock, ruffed grouse, ring-necked pheasant (winter cover), raptors (e.g., red-tailed hawk), cottontail, and several species of small mammals, reptiles, and amphibians.

3. Palustrine Emergent Wetland - a wetland type that is especially abundant along Duck Creek, but is also numerous in the ponds, potholes, and old river oxbows of the study area. The vegetative community includes river bulrush, spikerush (*Eleocharis* sp.), bluejoint, arrowhead (*Sagittaria* sp.), water plantain, phragmites, sedge, and cattail. These wetlands provide excellent waterfowl (e.g., Canada goose, mallard, blue-winged teal) breeding and feeding habitat as well as prime habitat for wading water birds (e.g., great blue and green herons, great egret, American bittern, greater sandhill crane), and furbearers (e.g., muskrats, mink, otter). Emergent wetlands also provide spawning and nursery habitat for fish such as northern pike, perch, and largemouth bass.

4. Field - This type of habitat is especially evident on the Pine Island State Wildlife Area (PISWA) on the south side of the Wisconsin River, just west of State Highway 78. Prairie grass fields are used by ring-necked pheasant, quail, gray partridge, mourning dove, meadowlark, badger, several species of small mammals, and raptors which prey upon them.

[1/] Classification of Wetlands and Deepwater Habitats of the United States, USDI, Fish and Wildlife Service, December, 1979

Table 1. Classification of the Major Wetland Types in the Portage Study Area

Type	System	Class	Subclass	Water Pegimen Modifer	Dominant Vegetative or Macroinvertebrate Types	Subordinate Vegetative or Macroinvertebrate Types	Primary Location
7	Palustrine	forested wetland	broad-leaved deciduous	semipermanently flooded	swamp white oak	river birch, ash, silver maple	Wisconsin and Baraboo River floodpains
6	Palustrine	scrub-shrub wetland	broad-leaved deciduous	seasonally flooded or saturated	tag alder	silver maple, red-osier dogwood, willow, reed canarygrass	Fox River floodplain and the Big Slough area
3-5	Palustrine	emergent wetland	persistent	semipermanently flooded	sedges	cattail, river bullrush, bluejoint, phragmites, spikerush	Duck Creek, Long Lake area, the oxbows of the Baraboo and Wisconsin Rivers and most wetlands between STH 51 and the Wisconsin River floodplain forest
	Lacustrine	unconsolidated bottom	mud or organic	permanently flooded	*	*	Long, Silver and Swan Lakes and Lake George
	Riverine	unconsolidated bottom	sand or mud	permanently flooded (perennial streams)	Diptera	Amphipoda, Gastropoda	Fox River
					Diptera	Trichoptera, Gastropoda	Wisconsin River
					*	*	Baraboo River, Duck and Neenah Creeks

Note - Classification based on USFWS - Wetlands of the United States, Circular 39 and Classification of Wetlands and Deepwater Habitats of the United States

* Dominant and subordinate orders of macroinvertebrate species unknown

5. Oak Forest - Farther west but in the same area of the PISWA, the Field habitat grades to Oak Forest. White oaks, river and paper birch are typical along with cedar, sumac, pine plantings, and tag alder shrubs. Ruffed grouse, white-tailed deer, red and gray squirrel and cottontail are some of the species that use these areas.

6. Cropland - Corn and alfalfa are the principal crops grown. Ring-necked pheasants, quail and gray partridge are common near intensively cultivated farmlands where shrubs and brushy fence rows are present.

7. Lacustrine Wetland - includes those water bodies such as lakes and ponds greater than 20 acres. Long Lake, Silver Lake, Lake George, and Swan Lake are examples of Lacustrine Wetlands in the study area.

8. Riverine Wetland - includes those wetlands and deepwater habitats within a channel, and usually flowing water systems. The Wisconsin, Baraboo, Fox Rivers and Neenah and Duck Creeks are Riverine Wetlands in the study area.

Our Stage 1 report described the fish and other aquatic life that inhabit the lakes, rivers, and creeks of the Portage area.

PLANS OF DEVELOPMENT AND IMPACTS - WITH THE PROJECT

Our analysis evaluates the flood control alternatives listed below. The latter are based on the conclusions of your January, 1981 Stage II Draft Feasibility Report and results of technical meetings among the Corps, Wisconsin Department of Natural Resources (WDNR) and the Service.

Our acreage calculations of fish and wildlife habitat affected by the various levee alternatives are based on data contained in the Stage II Feasibility Study Report and also, assumptions obtained from your Environmental Resources Branch. We are assuming the levee slopes are generally 3:1 riverward and 5:1 landward and that an additional 200 foot corridor, excluding the area occupied by the existing levees, would be required to renovate the existing levees at Portage.

ALTERNATIVE I Improve the Portage Levee

A. Improve the Existing Portage Levee

The existing Portage levee would be raised and widened along approximately 13,800 feet of its existing alignment from the Portage Canal downstream to where the Portage levee ties into State Trunk Highway (STH) 51. The Service has two primary concerns with this portion of the alternative. As proposed, the first 6,000 feet of levee improvement (beginning at the Portage Canal) would encroach into the Wisconsin River channel approximately 200 feet if the 3:1 riverward and 5:1 landward slope criteria are used.

Accordingly, approximately 28 acres of shallow riverine backwater habitat would be eliminated which would cause an unnecessarly loss of aquatic habitat and an undesirable loss of floodplain conveyance capacity. Therefore, to minimize adverse aquatic impacts by levee encroachment, we recommend that levee construction along this 6,000 foot length incorporate appropriate structural design modifications to allow for a 1:1 riverward slope or as near to that as feasible. Also, recognize that levee development must be compatible with Wisconsin's Flood Plain Management Program as described in Chapter NR 116 of the Wisconsin Administrative Code, portions of which state:

> "NR 116.13 Uses in floodway areas. (1) Prohibited Uses. The following uses are generally prohibited in floodway areas; Any fill, deposit, obstruction, excavation, storage of materials, or structure which, acting alone or in combination with existing or future similar works, will cause an increase equal to or greater than 0.1 foot (3 cm.) in the height of the regional flood or will affect the existing drainage courses of facilities."

Levee construction, as proposed, through its encroachment into the floodway, may in fact conflict with the quoted statute section.

The remaining 7,800 feet of the Portage levee extends through Palustrine Forested Wetland (PFW) and Palustrine Emergent Wetland (PEW). Approximately 36 acres of this habitat and its associated wildlife would be eliminated in the 200 foot corridor required for levee renovation. Another major concern with this alignment is that with the project 55 acres of PFW and PEW located between STH 51 and the renovated Portage levee would no longer be flood prone and thus susceptible to urban development (Figure 2). We believe this plan would contravene the letter and spirit of Executive Orders 11988 and 11990 on Floodplain Management and Protection of Wetlands and would be unacceptable to the Service unless the area in question is afforded binding protection to preserve existing wetland wildlife habitat. Therefore, if renovating the Portage levee along its existing alignment is selected as part of the preferred flood control plan, we recommend this parcel be purchased at project cost (including subsequent operation and maintenance costs) as mitigation land to offset project-caused habitat losses. We would also be amenable to other forms of protection which would place the wetland in public reserve, such as permanent easement. The question of what Federal, state, or local agency would be responsible for management of those lands should be resolved during the Advanced Design Phase of project planning, if this alternative alignment is selected.

B. Construct a New Portage Levee

The other portion of Alternative I - Improve the Portage levee includes a new 2,500 foot levee to protect Ward 8 of the city from flooding (Figure 2). As proposed, the levee would begin at STH 33 and extend westward. The Service has no major concerns with this plan as long as the levee is aligned just riverward of existing urban development. This alignment would not disturb appreciably the Palustrine Forested Wetland located adjacent to Pauquette Park and the Wisconsin River.

ALTERNATIVE II Ring Dike Around Ward 1 in Portage

During our review of preliminary project information, we designed a levee alignment that could substantially reduce project impacts on fish and wildlife resources. Since it was not included as a Corps' proposed alternative, we presented the ring dike proposal in our Stage II Report as another levee alternative that should be evaluated during Stage III studies.

A. FWS Proposed Ring Dike Alignment

As discussed in our Stage II report dated January 16, 1981 we believe our suggested ring dike alignment around Ward 1 of the city would "conceptually"[2/] alleviate flooding to the majority of residential Portage and still maintain a high degree of environmental protection for the abundant floodplain forests and other wetlands that abut the city. To reiterate, we propose the following alignment for your analysis (Figure 2).

1. Beginning at the Portage Canal, construct the new levee along the existing Portage levee alignment and incorporate our recommended slope modifications for the first 6,000 feet, as previously discussed.

2. Construct a new levee at the junction of STH 51 and Ontario Street; extend it northeast along Ontario Street (just east of the houses) to the Chicago, Milwaukee and St. Paul (C M & St. P) Railroad tracks; continue northwest along the north side of the tracks to Wauona Trail Road and lastly, follow the east side of the road northeast to a point where the levee could tie into STH 33 (2.1 miles of new levee). Floodgates could probably be installed across STH 51 and the C M & St. P. Railroad tracks to avoid raising the road and railroad beds. Highway 33 would probably have to be elevated in the Fox River and Portage Canal area for 100 and standard year flood protection. Much of the land adjacent to the Fox River just northwest of STH 33 between Hamilton Street (north of E. Albert St.) and the Portage Canal is primarily Palustrine Scrub/Shrub wetland; this area should not be flood proofed by levees.

3. Flood proof or evacuate the few scattered unprotected dwellings east of our proposed Ontario St. and Wauona Trail Road levee alignments.

We understand that regardless of which levee alignment is selected, the proposed 1500 foot extension of the Lewiston levee would be necessary to prevent flooding of the city from the west over U.S. Highway 16.

Construction of a ring dike would also fill wetlands. Approximately 51 acres of mainly Palustrine Scrub/Shrub wetland in the Fox River basin would be eliminated by our suggested alignment. However, if this alternative meets other flood control criteria, we believe its merits outweigh the environmental damage for the following reasons.

[2/] We realize the plan must be analyzed for all appropriate flood control criteria besides just environmental considerations.

1. The ring dike would form a boundary separating development from the valuable Fox River wetlands. The observable trend is sporadic filling and continuing encroachment by development eastward into the Fox River wetlands.

2. Again, "conceptually" flood damage to property in Caledonia Township with the project, a serious concern of Caledonia landowners, should be minimized because the Wisconsin River floodplain would not be constricted to the degree proposed by the Portage levee improvements. Rather, floodwater could overtop the existing Portage levee and utilize the water retention capabilities of the Fox River marshes. However, if the Lewiston levee is improved, we presume there would be some flood flow changes in the Wisconsin River channel that could affect Caledonia Township.

3. The wetland located between STH 51 and the existing Portage levee would remain floodprone and thus, not susceptible to development.

If this ring dike alternative were developed the existing Portage levee should be left intact to provide its designed flood protection.

B. Corps of Engineers Proposed Ring Dike Alignment

Although the Corps of Engineers' suggested modification to our ring dike alignment would be shorter, (approximately 1.9 miles of new levee instead of 2.1 miles) the alignment is unacceptable because:

1. The levee would fill most of a 2 acre Palustrine Emergent Wetland (cattail marsh) located in the southeast quarter of Section 21, T12N, R9E (Figure 2).

2. Approximately 25 acres of Palustrine Scrub/Shrub Wetland would remain west or behind the Corps' suggested ring dike which would in all likelihood be displaced by urban development. Taking into account the wetland acreage filled by each levee alignment (FWS:51, CE:45), the FWS's alternative would minimize wetland losses by preserving 19 more acres; 2 of which are Palustrine Emergent Wetlands and 17 are Palustrine Scrub/Shrub Wetlands.

ALTERNATIVE III Improve the Lewiston Levee

This alternative would improve approximately 12,670 feet of the Lewiston levee. On the river side, this stretch of levee is almost entirely bordered by Palustrine Forested Wetland. We understand from your environmental staff that since County Trunk Highway (CTH) O abuts the landward side for almost its entire length, levee renovation would in all likelihood occur riverward. It appears that the loss of approximately 58 acres of bottomland wildlife habitat would be unavoidable with little opportunity for on site mitigation. However, we prefer that levee improvements occur along the existing Lewiston alignment as proposed rather than encroach further into the floodplain where better undisturbed bottomland habitat exists.

ALTERNATIVE IV Lewiston Levee Extension

To prevent flood overflows across U.S. Highway 16, a new 1,500 foot levee is proposed near CTH O about 1 mile east of where the Lewiston levee ends (Figure 2). Assuming the alignment would be as close as possible to CTH O (allowing for avoidance of residential property along the road), no significant adverse effects on wildlife resources are anticipated. Approximately 7 acres of residential property, cropland, and abandoned farm fields would be affected. The fields contain several pockets of sedge meadow mixed with cedar, pine and various shrubs.

ALTERNATIVE V Improve the Portage and Lewiston Levees and Extend the Lewiston Levee

This alternative is a combination of those measures proposed in Alternatives II, III and IV. The overall impact of this alternative on fish and wildlife resources would be the total of those impacts described for each alternative. Therefore, while we envision no major problems associated with work on the Lewiston levee, we have major concerns with the Portage levee portion of the project. Again, several options are available which would minimize project damages to fish and wildlife habitat while providing the desired level of flood protection.

ALTERNATIVE VI Nonstructural Measures

Historically, nonstructural solutions to flooding problems have been under-emphasized resulting in reductions of flood flow capacity and concomitant losses. On a long term basis, nonstructural solutions to flooding are probably the least destructive and best solution for both people, fish, and wildlife. Relative to the problems at Portage, nonstructural solutions may be workable in certain geographic areas of the floodplain and therefore, could be a part of a combination of measures included in the final comprehensive flood control plan for Portage. Nonstructural measures such as floodplain evacuation, zoning to restrict development, and structure floodproofing generally have minimal affects on the floodplain environment. Accordingly, such measures should be used where project costs and/or environmental damage can be reduced.

OTHER PROJECT EFFECTS

Construction Impacts

Since valuable fish and wildlife habitat occurs adjacent to the existing levees, construction impacts are a major concern. Consequently, our comments that follow regarding equipment storage areas, disposal sites, construction access, and borrow areas are intended to help you develop environmentally acceptable plans.

Equipment Storage and Disposal Sites

Filling wetlands to create temporary equipment storage areas is unacceptable. Further, the use of wetlands and floodplains should not be considered for disposal sites for any excess excavated material generated during levee renovation. Rather, upland sites of low wildlife value should be found. For example, there are ample upland fields on the north side of Portage near STH 51 that should be investigated. Also consideration should be given to the beneficial use of waste material such as stockpiling for garden soil, cover for sanitary landfills, fill for other local construction and sand for roads.

Construction Access

There may be cases during construction where temporarily filling wetlands and floodplains to allow for machinery access is unavoidable. If this situation occurs, the fill must be designed to prevent erosion while in place. Subsequently, all material should be removed immediately after construction; the area restored to its original contour, and seeded with native vegetation or otherwise returned to its preproject condition.

Borrow Areas

Borrow areas for construction fill can involve a sizeable area and result in significant adverse environmental effects if not sited properly. We understand that one area being considered for acquisition of levee construction material is the bed of the Wisconsin River. The effects of in-channel excavation are difficult to predict or control and should be avoided. For exmaple, some adverse impacts that could result downstream from the translocation of a heavy sediment load include: 1) filling riverine wetlands, slack pools, and shallow bays which are the most biologically productive areas of a river, 2) creating depressions in the riverbed that may strand fish and other aquatic life during low water periods and 3) change existing flow patterns causing dewatering of portions of the channel thus eliminating aquatic habitat. Since the work would occur in navigable waters, Federal and state permits would be required and these are typical questions and concerns that would arise during the permit review process. The Service would probably oppose a permit of this type because of the high potential for significant project-induced damages to fish and wildlife resources.

In summary, we recommend that during Advanced Design Planning you screen proposed equipment storage areas, disposal sites, and borrow areas with the WDNR, EPA, the Service and other interested organizations to minimize degradation of fish, wildlife and the habitat upon which they depend.

Levee Maintenance

We are informed that the levees must be maintained in a grass cover to absorb runoff water and prevent bank erosion. Accordingly, with the project, there would be an opportunity to encorage nesting of certain upland game and song-birds. If the levees were planted with suitable vegetation which was allowed to grow long enough to provide dense nesting cover, birds such as ring-necked pheasant, bobwhite and meadowlarks may establish nests.

The destruction of ground nesting birds by agricultural machinery is well known. Egg mortality from spring plowing and brood mortality from cutter blades during early summer harvest can be devastating to bird reproductive success. Therefore, if the levees must be mowed timing is critical. A stipulated condition of the Operation and Maintenance Agreement must prohibit mowing the levees until after August 1, when most bird nesting and brood activity is completed. Otherwise, attempts at passive management of the levees for ground nesting birds would be negated. Further, greater nesting success and better habitat suitability would result if mowing was not conducted every year but rather at 3 to 5 year intervals. Residual cover left from the previous year is critical to early spring nesting and thus, would be much denser if not mowed the previous year.

The type of cover (such as switchgrass, alfalfa or another hay crop) would in part influence the species and numbers of birds that nest on the levees. We recommend that you contact the wildlife manager for the Pine Island State Wildlife Area (Poynette Office, 608-635-4496) for information on the appropriate vegetative plantings. This coordination would insure that levee wildlife management would be compatible with other management objectives occurring in nearby State Wildlife Areas.

ENVIRONMENTALLY SENSITIVE AREAS

Our Stage II report described several environmentally sensitive areas in the project area that should receive special consideration during the development of any flood control plan: the Pine Island and Swan Lake State Wildlife Areas; Baraboo River Floodplain Forest (Natural Area of Statewide Significance); greater sandhill crane nesting habitat; red-shouldered hawk nesting habitat (State Threatened species); speckled chub and black buffalo habitat (State Threatened fish species); and the Leopold Memorial Reserve, a National Historic Landmark administered by the LMR Head Foundation, 201 Waubesa Street, Madison, Wisconsin. With the possible exception as noted below, none of the alternatives as proposed for Stage III study should affect these areas appreciably. However, possible exceptions could involve the following:

1. Habitat damage could result on the Pine Island State Wildlife Area (PISWA) if the Portage and Lewiston levees on the north side of the Wisconsin River were improved without corresponding improvements to the Caledonia levee. The Caledonia levee is located along the south side of the Wisconsin River and separates most of the PISWA from river overflows during high water events (Figure 2). Obviously, without improvements, this levee would be the weak link in the Portage levee system and would probably become overtopped or breached during a major flood. The WDNR has serious concerns with possible flood damage of critical wildlife habitat areas on the PISWA. The effects on the south side of the river

resulting from improving only the north side levees needs further hydraulic and environmental analysis. It may be necessary to develop a mitigation plan for the PISWA particularily if the recommended plan assumes the PISWA would be used as an overflow area. Since WDNR land is involved, close coordination with the Department is paramount during development of a flood control plan for Portage.

2. Alternative locations of disposal sites, equipment storage areas, and borrow areas need to be identified. For example, speckled chub and black buffalo habitat could be degraded if borrow material were excavated from the Wisconsin River channel.

3. The hydraulic effects of the Lewiston levee improvements upon the Leopold Memorial Reserve need to be analyzed.

More information is needed before the Service can assess the impacts upon fish and wildlife resources of items 1 - 3.

ENDANGERED AND THREATENED SPECIES

A review of the Fish and Wildlife Service's "Red Book of Endangered Species" indicates that one listed species, the peregrine falcon (*Falco peregrinus*) is known to occur in Columbia County. This species is a transient during spring and fall migration but potential reintroduction sites along the Wisconsin River have been identified. Typically, these sites occur on cliff or rock outcroppings adjacent to the river.

Our Stage 2 report notes several state listed species of endangered or threatened species known to occur in the study area. We suggest you contact the WDNR Office of Endangered Species in Madison for their assessment of project effects on these organisms.

CONCLUSIONS

In accordance with the U.S. Fish and Wildlife Service's Mitigation Policy[3/], we classify affected habitats in Resource Category 3: "Habitat to be impacted is of high to medium value to evaluation species and is relatively abundant on a National basis" (possible exceptions are Palustrine Forested and Palustrine Emergent Wetlands; however, locally they are relatively abundant). Accordingly, our mitigatic goal is no net loss of habitat value while minimizing loss of in-kind habitat value. If losses are likely to occur, they should be rectified immediately, reduced or eliminated over time. Mitigation in this category could also involve compensation by replacement of habitat lost with the project, although not necessarily on an acre for acre basis.

Our suggested mitigation plans to minimize adverse impacts upon fish and wildlife resources are shown, by alternative, in Table 2.

[3/] Published in the Federal Register, Vol. 46, No. 15, Friday, January 23, 1981.

Table 2 - Fish and Wildlife Service mitigation measures by alternative

Alternative		Mitigation Recommended	
I.	Improve the Portage levee along existing alignment; including a new levee along Ward 8 of the city.	Ia.	Purchase at project cost the 55 acres of wetland wildlife habitat located between STH 51 and the existing Portage levee.
		Ib.	Modify the Portage levee riverward slope to 1:1 along Ward 8 and from the Portage Canal to 1.1 miles downstream.
		Ic.	Where possible, expand the levee landward rather than riverward to minimize levee encroachment into the floodplain.
		Id.	Allow the grass cover on the levees to remain unmowed until after August 1, when most bird nesting and rearing activity is over. Also, mow every 3-5 years to allow dense nesting cover to become established, rather than annual mowing.
II.	Ring dike around Ward 1 of the city.	IIa.	Follow FWS suggested alignment.
		IIb.	Incorporate items Ib, Ic, and Id above.
III.	Improve the Lewiston levee	IIIa.	Incorporate items Ic and Id above.
IV.	Extend the Lewiston levee	IVa.	Align the levee as close as possible to CTH O
		IVb.	Incorporate items Ic and Id above.
V.	Improve the Portage and Lewiston levees and extend the Lewiston levee along existing alignments	Va.	Incorporate items Ia through Id above.
VI.	Nonstructural Measures	VIa.	Incorporate nonstructural flood prevention measures such as floodplain evacuation, zoning, and flood proofing into the recommended plan in those areas of the floodplain where structural costs and/or environmental damage could be reduced.

RECOMMENDATIONS

1. The FWS suggested ring dike around Ward 1 of the city (Alternative IIA) is the best structural plan to minimize adverse impacts to fish and wildlife resources.

2. If the selected plan includes improving the Portage levee along its existing alignment, the 55 acres of wetlands located between STH 51 and the existing Portage levee should be purchased at project cost, as mitigation lands to compensate for project caused losses. Other options to place the wetlands in public reserve besides acquisition could be investigated. Without this stipulation the Service would probably oppose implementation of this alternative.

3. To avoid excessive filling in the Wisconsin River channel by reconstruction of the Portage levee in the city (Portage canal to approximately 1.1 miles downstream), appropriate structural design modifications must be incorporated to allow for a 1:1 riverward slope or as near to that as feasible. This would also apply to the new levee proposed along Ward 8 of the city.

4. Wherever possible, the existing levees should be widened landward rather than riverward to retain the maximum amount of functional floodplain.

5. Borrow sites and equipment storage areas must be located on upland sites outside of environmentally sensitive areas. Disposal sites for unusable excavated material must be similarly located. Interagency coordination among the Service, WDNR and EPA must occur during advanced design planning to select acceptable sites commensurate with Federal, state and local rules and regulations.

6. Unavoidable wetland fills for construction access should be restored to the original wetland contour immediately after project completion.

7. If the levees must be mowed it should occur on a 3 to 5 year cycle. In any event, mowing must not occur prior to August 1.

8. Changes in flood stage of the Wisconsin River resulting from proposed improvements to the Lewiston levee must be analyzed in terms of their effects on the Leopold Memorial Reserve. Particularily, levee improvement on the north side of the river must be designed to avoid flooding the historic Leopold cabin located on the south side of the river. The Service would likely oppose any plan that would physically modify or otherwise degrade the Reserve.

We trust this report and our previous correspondence (April 1, 1977, May 5, 1977, February 1, 1979, and January 16, 1981) will help your analysis of a feasible flood control plan and look forward to providing future input in the development of an environmentally acceptable plan.

Sincerely yours,

James L. Smith
Acting Area Manager

cc: Bill Tans, Bureau of Environmental Impact, DNR, Madison, WI
Barbara Taylor, US EPA, Chief, Environmental Impact Review Staff, Chicago, IL

LIST OF PREPARERS

James D. Fossum (principal preparer), Fish and Wildlife Biologist, Green Bay Field Office, B.A. in Biology - 1969, Winona State University, Winona, Minnesota. M.S. in Biology - 1975, St. Mary's College, Winona, Minnesota

Nevin D. Holmberg, Field Supervisor of the Green Bay Field Office, Green Bay Wisconsin, B.S. in Wildlife Management - 1969, Humboldt State University, Arcata, California. M.S. in Wildlife Management - 1975, Humboldt State University, Arcata, California

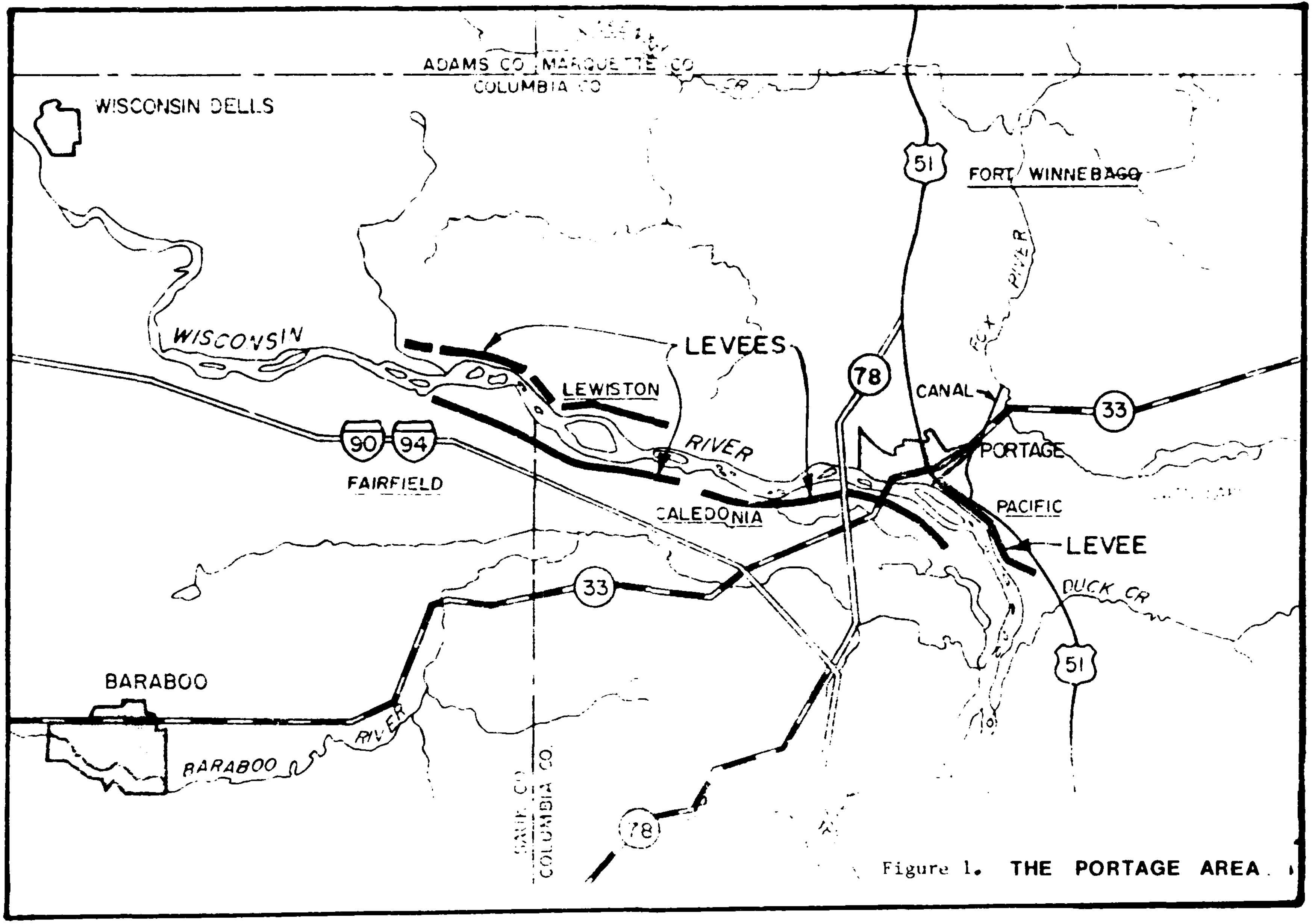


Figure 1. **THE PORTAGE AREA**

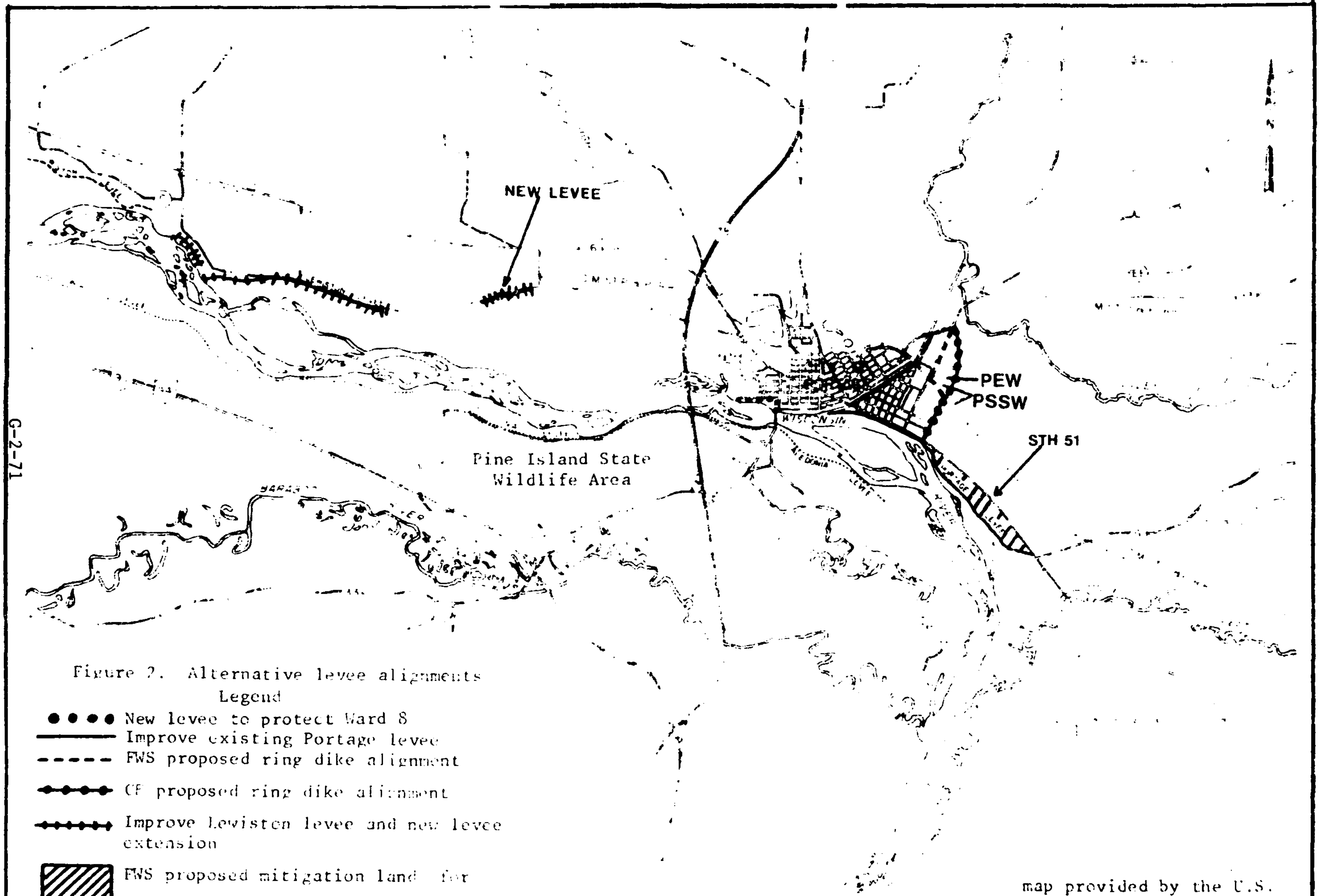


Figure 2. Alternative levee alignments

Legend

- ● ● ● ● New levee to protect Ward 8
- ——— Improve existing Portage levee
- - - - - FWS proposed ring dike alignment
- CE proposed ring dike alignment
- Improve Lewiston levee and new levee extension
- FWS proposed mitigation land for

map provided by the U.S.

ABSTRACT FROM

DRAFT ENVIRONMENTAL IMPACT STATEMENT

FOR WASTEWATER TREATMENT FACILITIES

FOR THE CITY OF PORTAGE, WISCONSIN

November 1979

U.S. Environmental Protection Agency

Region V, Chicago, Illinois

Pages 2-1 to 2-46

2.0. AFFECTED ENVIRONMENT: NATURAL ENVIRONMENT

2.1. Meteorology

The closest source of readily available meteorological data is located at Truax Field in Madison, Wisconsin, approximately 35 miles south of Portage. Portage and Madison share the same continental-type climate and the same general topography. As a result, the temperature, precipitation, and wind characteristics of the two areas are quite similar. Climatological data from the National Weather Service office in Madison for the period of record, 1941 to 1970, are presented in Appendix A, Table A-1.

Portage experiences a large annual temperature range and frequent fluctuations in temperature over short periods of time. Temperatures in the summer months average 68°F, whereas the average for the winter months is less than 20°F. Daily mean temperatures average more than 42°F for approximately 200 days and less than 32°F for more than 100 days per year. The average annual temperature is slightly less than 45°F.

Over 60% of the annual precipitation occurs during the five months from May through September. The average annual precipitation in the area, as recorded over the 30-year period from 1941 through 1970, is approximately 30 inches. The maximum monthly rainfall occurred during July 1950, when approximately 11 inches of rain fell, with a maximum of close to 5 inches occurring during a single 24-hour period. National Weather Service precipitation data for Madison are contained in Appendix A, Tables A-2 and A-3.

During an average winter, 1.0 inch or more of snow covers the ground approximately 60% of the time from 10 December to 25 February. From the beginning of December through most of March the ground usually is frozen, with an average frost penetration of 25 to 30 inches. The growing season lasts for an average of 175 days. The first frost in autumn usually occurs between 6 October and 25 October, while the last frost in spring usually occurs between 17 April and 2 May.

The prevailing wind direction in the study area is from the south for 7 months during the year. In January and February the wind is from the west-northwest; in March and April the prevailing wind direction is from the northwest; and in December the wind is from the west. The average wind speed is 9.9 miles per hour (mph), with the peak monthly average speed of 11.6 mph occurring in April and the lowest monthly average speed of 8.1 mph occurring in August. Annual and seasonal wind frequency data compiled over a 5-year period (1967-1971) for Madison, Wisconsin, are presented in Appendix A, Tables A-4 to A-7.

Mixing layer height, a meteorological parameter that is important in the determination of air quality, is defined as the height above the surface through which relatively vigorous vertical mixing occurs. The afternoon mixing heights tend to be relatively low in the study area, partially because of the moderating influence of the Great Lakes on surface heating by the sun. Interpolated mean mixing layer heights for the area are presented in Table 1.

Table 1. Interpolated mean mixing layer heights in meters (m) at Portage, Wisconsin (Holzworth 1972).

Season	Morning	Afternoon
Winter	500	600
Spring	500	1,400
Summer	300	1,600
Autumn	400	1,100
Annual	500	1,200

2.2. Existing Air Quality

The study area is part of Federal Air Quality Control Region (AQCR) Number 240, which includes nine counties in Wisconsin: Columbia, Dane, Dodge, Green, Iowa, Jefferson, Lafayette, Richland, and Sauk. The proposed wastewater treatment project must be compatible with the National Ambient Air Quality Standards shown in Appendix A, Table A-8.

The Portage area also is under the jurisdiction of WDNR and thus is subject to the provisions of Chapter NR 154 of the Wisconsin Administrative Code that deal with air pollution control. The Wisconsin Ambient Air Quality Standards are identical to the Federal standards in Appendix A, Table A-8. The specific Wisconsin air pollution control regulations that may be especially applicable to the proposed project include Section NR 154.11 (2), "Control of Fugitive Dust Emissions," which is important during the construction phase of the project; and Section NR 154.18 (1), "Malodorous Emissions--General Limitations," which prohibits the emission of substances with an objectionable odor. An odor is deemed objectionable if: (1) a decision is made by WDNR to that effect, or (2) 60% of a random sample of persons exposed to the odor consider it to be objectionable.

The principal point sources of atmospheric emissions in Columbia County, as well as the average amounts of contaminants that the sources emit, are presented in Appendix A, Table A-9. The major source of air contaminant emissions in the Portage area is the Columbia Generating Station (CGS) of the Wisconsin Power and Light Co., located approximately 4.5 miles southeast of Portage. The Station accounts for more than 90% of the particulate, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO) emissions in Columbia County. The second-largest source of particulates is the Martin-Marietta sand processing plant, which is located approximately 0.5 mile northwest of the CGS. Primarily because of these sources, USEPA has designated the area surrounding these emission sources (approximately 4 square miles) as a non-attainment area in which the primary (health-related) particulate standard of 260 ug/m is not met. An area in Pacific Township approximately 1.0 mile east of the non-attainment area does not meet the 150 ug/m^3 secondary (welfare-related) particulate standard. The remainder of Columbia County (including Portage) does not exceed national standards for particulates, SO_2, NO_2, or CO. The only other air quality problem is due to photochemical oxidants or ozone (O_3), which is a problem pollutant over much

of the United States because of the long-distance transport and reaction of precursor emissions such as hydrocarbons (HC) and nitrogen oxides (NO_x) from urban areas. All three O_3 monitoring locations in Columbia County recorded numerous excesses of the 1-hour, 160 ug/m^3 primary and secondary oxidant standards during 1976. (The O_3 standard was revised to 240 ug/m^3 on 8 February 1979.)

The 1976 Wisconsin air quality data (monitored values for total suspended particulates, SO_2, NO_2, and O_3) are presented in Appendix A, Table A-10. Air quality data for the eight monitoring stations in Columbia County, as well as the distance and direction of each of these sites from Portage, also are included in Appendix A, Table A-10 and Figure A-1. HC and CO are not monitored in Columbia County, but WDNR has indicated that levels of these contaminants in the area are low, as it is relatively rural and free from major sources of these contaminants.

In summary, only particulates and oxidants pose air quality problems in or near the study area. The particulates result from specific point sources, and the oxidants result from long-distance transport and reaction of precursor emissions.

2.3. Sound

Information on ambient sound levels in the study area was not available. A sound survey was conducted by WAPORA on 27 and 28 March 1978. Four locations in noise-sensitive land areas were selected for measurement of current sound levels. The sampling locations are described as follows:

Location No.	Description
1	813 E. Edgewater Street
2	Cottage School, at the corner of Thompson Street and Brady Street
3	Veterans Memorial Field, at the intersection of Wauona Trail and Griffith Street
4	Old Indian Agency House, at the northern end of the Portage Canal

Sound levels in Portage are typical of the sound climate of a small city. Sound levels ranged from 42 to 55 dBA (adjusted decibels) at Location 1, 47 to 63 dBA at Location 2, and 43 to 58 dBA at Location 3. A level of 43 dBA was registered at Location 4. A summary of ambient sound levels is presented in Appendix B, Table B-1. The sampling locations also are described in Appendix B, Table B-1.

The principal sources of sound at Locations 1, 2, and 3 were automobile, truck, and railroad traffic. Automobile and truck traffic were

heaviest during the late afternoon and early evening hours. Railroad activity occurred regularly throughout the 24-hour period. The latter sound source contributed significantly to both daytime and nighttime sound levels near Locations 1 and 3. The principal sources of sound at Location 4 were wind and the distant noise of traffic on Route 33. Ambient sound levels exceeded USEPA guidelines (Appendix B, Table B-2) at Locations 2 and 3 by 6 and 2 decibels, respectively.

Ambient sound quality at Location 4 was sampled for only 25 minutes during daytime hours. No unusual activities such as road detours or construction occurred at the locations. Therefore, the data do not reflect any intrusive sounds.

Nomenclature, instrumentation, data collected, methods of data acquisition, and Federal guidelines for noise regulations are described in Appendix B. At present, neither Columbia County nor the State of Wisconsin has established guidelines for noise regulation.

2.4. Geology and Soils

2.4.1. Physiography and Topography

Due to the possible development of a land application alternative, the study area boundaries were extended to include potentially suitable sites. The expanded study area (Figure 3) overlaps the southeastern part of the Central Lake Plain and Moraine Province and the southwestern part of the Eastern Lake Plain and Moraine Province (Olcott 1968). Topography and landforms are characterized predominantly by glacial lake plain and morainic deposits that have been modified by surface-weathering agents and by the fluvial action of the Wisconsin River, the Fox River, Neenah Creek, French Creek, and Spring Creek. Major lakes in the study area include Swan Lake, Silver Lake, and Mud Lake. The major physiographic and topographic features of the expanded study area are depicted in Figure 4.

Broad, level floodplains occur along the Wisconsin River, the Fox River, and minor streams (Section 3.4.). A large lowland area northwest of Portage is part of the floodplain of the Wisconsin River. Land cover consists primarily of crops and marsh. Elevations range from less than 780 feet mean sea level (msl) to approximately 820 feet msl.

Upland areas are situated to the east and west of the Fox River in the northern two-thirds of the study area. Drumlins, kames, moraines, and bedrock outcrops produce a rolling and hummocky topography. The landscape often is pitted with numerous small depressions. Elevations range from 800 feet msl to more than 1,060 feet msl, and slopes often exceed 15%. High elevations are associated primarily with areas of bedrock outcrop.

2.4.2. Surficial Geology

Pleistocene deposits in the expanded study area were produced by the northeast-southwest advance of the Green Bay Lobe during the Wisconsinan stage of glaciation (Columbia County Planning Department 1970). Glacial

CONTOUR INTERVAL 20 FEET

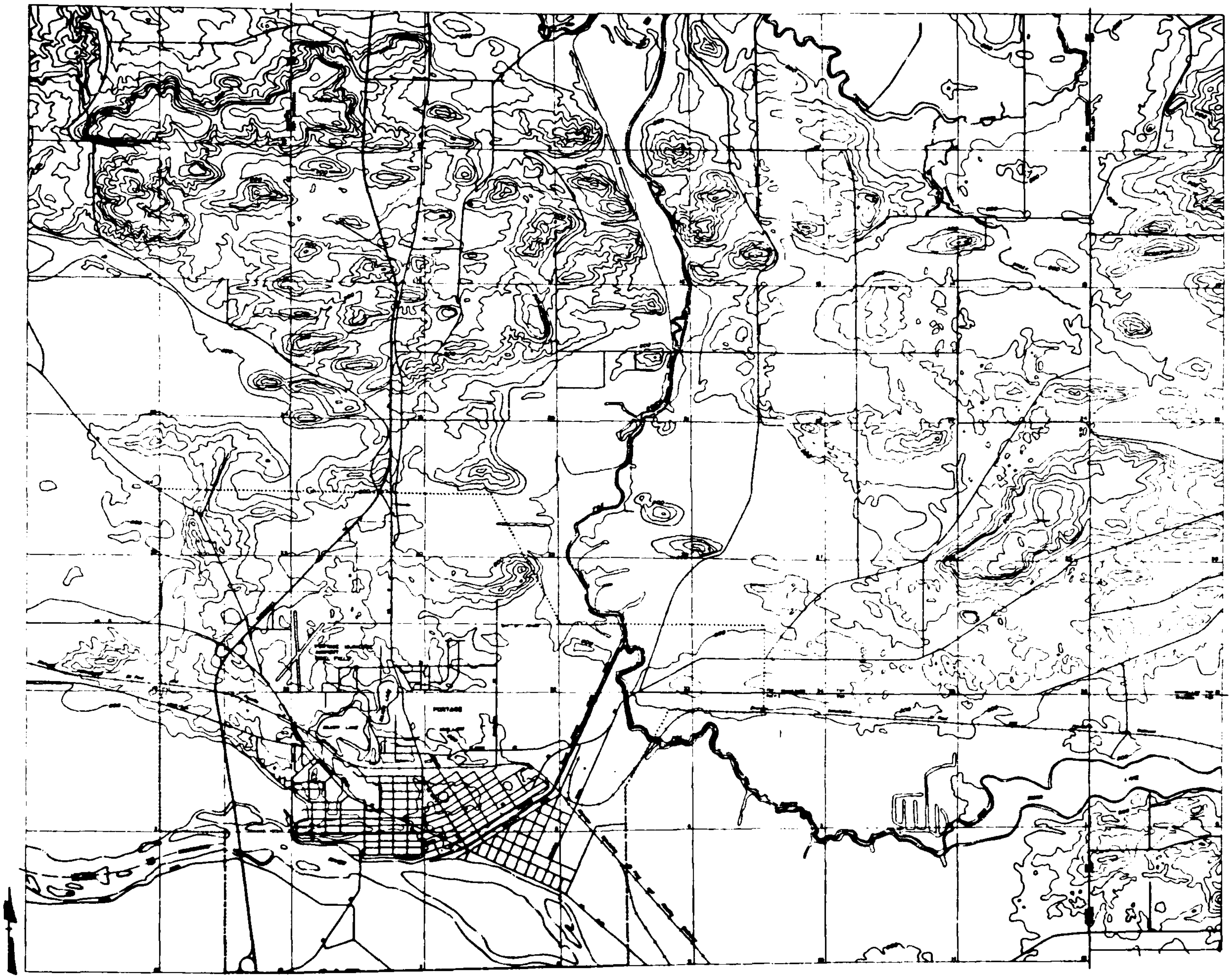


FIGURE 4 TOPOGRAPHY and PHYSIOGRAPHY

drift consists predominantly of ground moraines, end moraines, outwash deposits, and lacustrine deposits (Figure 5). The thickness of glacial drift ranges from less than 50 feet in northwestern and eastern regions to more than 200 feet in preglacial bedrock valleys. Locally, drift may be absent.

Ground moraine deposits consist of glacial till that was deposited directly by glacial ice advancing over bedrock or older glacial deposits. Sediments are unsorted, unstratified mixtures of clay, silt, sand, and gravel (Olcott 1968; Hindall and Borman 1974). Lenses of sand and gravel may occur locally. In some areas, an older ground moraine was molded by an advancing glacier into clusters of elongated, egg-shaped mounds called drumlins. The axes of the drumlins roughly parallel the direction of glacial movement (Gilluly and others 1968; Holmes 1965).

End moraine deposits mark the position of a glacier during a halt or minor readvance and are composed of glacial till that was deposited along the edge of a relatively stagnant ice sheet. The end moraines in the study area are associated with the Lake Mills Morainic System (Columbia County Planning Department 1970). Topography is characterized by belts of sharply rolling and hummocky land. Boulders, undrained depressions, and lenses of stratified sand and gravel are common.

Outwash deposits are composed predominantly of stratified sand and gravel that was deposited by glacial meltwaters. Grain sizes range from cobbles to fine sand. Cross-bedding and channel structures are common features. Kames are isolated or clustered hills of sand and gravel that represent steep-faced alluvial cones or deltas deposited by streams emerging at high levels from a temporarily stagnant ice front (Holmes 1965).

Lacustrine sediment accounts for most of the glacial drift in the study area. It consists of laminated fine sand, silt, and clay that were deposited in glacial lake basins. The glacial lake basin in the vicinity of Portage corresponds to a system of preglacial bedrock valleys (Olcott 1968; Hindall and Borman 1974). Lacustrine deposits are commonly underlain by glacial till and are overlain locally by marl and peat.

Examination of soil reports from the US Soil Conservation Service (1971), well logs (Wisconsin Geological and Natural History Survey n.d.), and data from soil borings (Ives and others 1973) has indicated that outwash sand and gravel deposits in the expanded study area are important sources of groundwater.

In addition to glacial drift, surficial deposits contain significant amounts of loess (aeolian silt and sand) and recent alluvium. Recent alluvium includes all detrital material deposited in valleys and depressions since the retreat of the last glacier. Sediments range from coarse sand and gravel in stream channels to fine sand and silt on floodplains. Undrained depressions commonly contain muck or peat.

2.4.3. Bedrock Geology

The bedrock formations in the expanded study area consist of gently-dipping, Upper Cambrian sedimentary rocks that overlie a Precambrian basement of igneous and metamorphic rocks. Strata generally

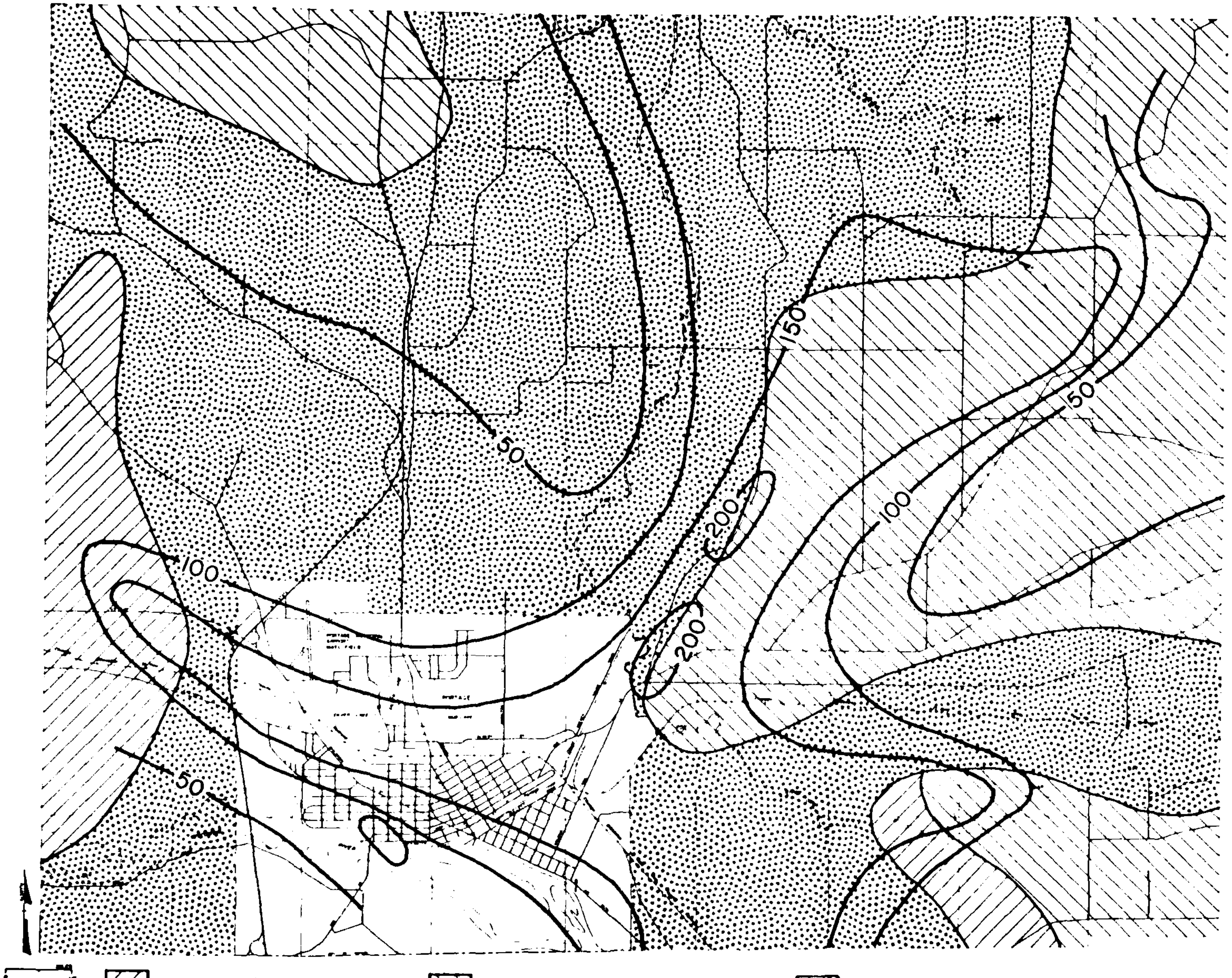


FIGURE 5 THICKNESS AND CHARACTER OF GLACIAL DRIFT

dip southeastward at approximately 15 to 20 feet per mile, following the slope of the Precambrian surface (Olcott 1968; Hindall and Borman 1974). The thickness of the beds generally increases in the direction of the dip. Upper Cambrian rocks consist of the Mt. Simon Sandstone, Eau Claire Formation (sandstone and shale), Galesville Sandstone, and Franconia Sandstone (McLeod 1975).

With the exception of a small area of Precambrian rhyolite in the northeastern part of the expanded study area, the bedrock surface consists entirely of Cambrian sandstones (Figure 6). Although there are insufficient data with which to differentiate individual formations, an examination of well records has indicated that the bedrock surface may comprise the Eau Claire, Galesville, and Franconia formations. The Eau Claire Formation contains some interbedded shale. However, the bedrock of this formation generally consists of light-colored, fine-grained to medium-grained, partly dolomitic sandstone.

Bedrock topography is characterized by deep bedrock valleys that extend through the central regions of the expanded study area and bedrock highs to the northwest, northeast, and east (Figure 6). Bedrock highs correspond to sandstone bluffs and ridges and may exceed 950 feet msl. The bedrock surface in these areas roughly follows the topography of the land.

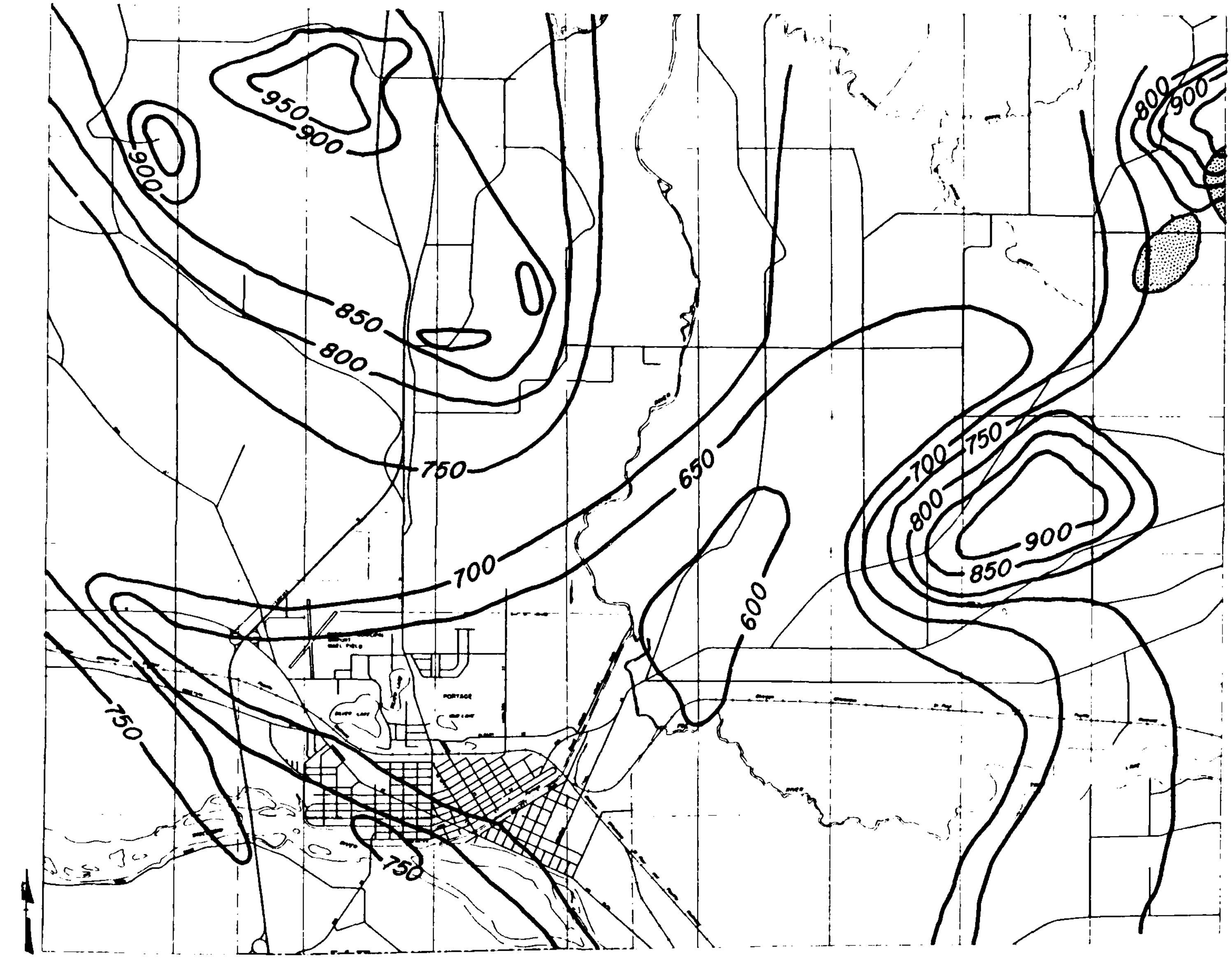
2.4.4. Soils

Soil characteristics are determined largely by the parent material and slope on which they were formed. Soil associations consist of groups of soil types that commonly occur adjacent to one another. Five soil associations are present in the expanded study area (Figure 7). Unless otherwise documented, soil information was obtained from the US Soil Conservation Service (1978).

The Granby-Alluvial land, loamy, wet-Morocco association occurs primarily in the southwest part of the expanded study area on the floodplain of the Wisconsin River. Elevations range from less than 780 feet msl to 820 feet msl. Most of the area is nearly level, but steep slopes 2 to 6 feet in length occur along old stream channels that meander through the area. This association is subject to seasonally high groundwater levels and to periodic flooding.

Granby soils account for approximately 20% of the association and generally are nearly level, poorly-drained, loamy sands developed in deep deposits of sand on outwash plains and river floodplains. They are characterized by rapid permeability and low available water capacity.

Alluvial land accounts for approximately 17% of the association. It consists predominantly of nearly level, poorly-drained and very poorly drained, sandy to loamy soils formed in stream sediments. The soils are characterized by a permanently high water table, moderate permeability, and high available water capacity. Runoff is very slow and ponding is frequent.



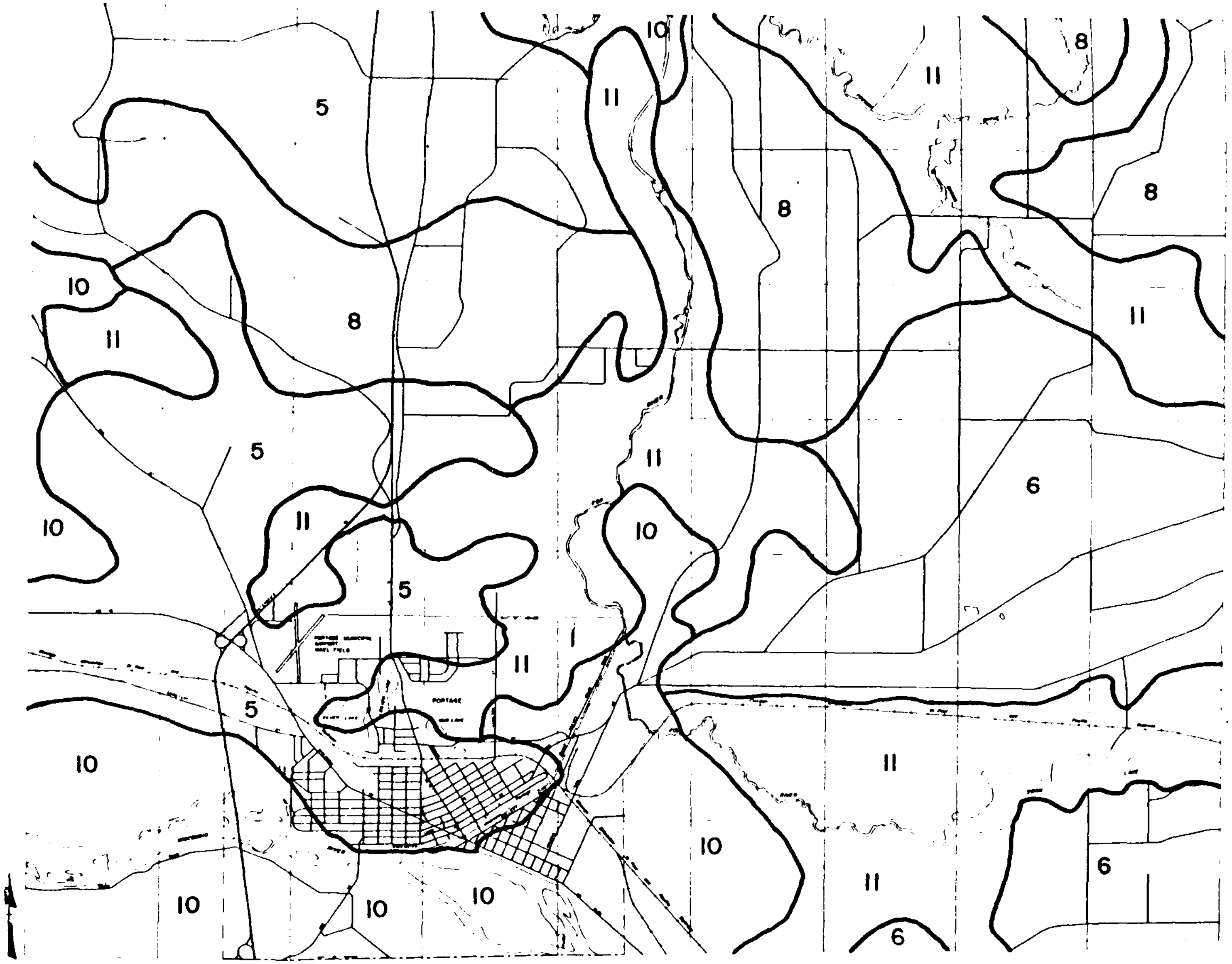
PALEOZOIC ERA

CAMBRIAN SANDSTONE

PRECAMBRIAN ERA

RHYOLITE

FIGURE 6 TOPOGRAPHY AND CHARACTER OF BEDROCK SURFACE



5 PLAINFIELD - OKEE

6 BOYER - OSHTEMO - DRESDEN

8 LAPEER - WYOCENA

10 GRANBY - ALLUVIAL LAND, LOAMY, WET - MOROCCO

11 HOUGHTON - ADRIAN - PALMS

FIGURE 7 SOIL ASSOCIATIONS

Morocco soils, which account for approximately 15% of the association, are nearly level, somewhat poorly drained, loamy sands developed in deep deposits of fine to medium sand on outwash plains, broad floodplains, and lake plains. During wet seasons, the water table is within 1 to 3 feet of the surface. Rapid permeability and low available water capacity are characteristic of this soil type.

The more important minor soils of this association include Colwood, Marshan, Otter, and Gilford soils. Colwood, Marshan, and Gilford soils occur on glacial lake plains, in stream valleys, and along drainageways. They consist of nearly level, moderately deep, poorly-drained and very poorly drained, loamy soils underlain by stratified silts and sands. Otter soils are composed of nearly level, poorly-drained silt loams that occur along valley floors, along streams, and in other low areas that receive runoff from adjacent uplands.

The Boyer-Oshtemo-Dresden association occurs in the eastern and southeastern sections of the expanded study area on rolling or undulating outwash plains. The landscape often is pitted with numerous small depressions. Outwash deposits typically contain large amounts of calcareous gravel and cobbles (Columbia County Planning Department 1970). This association contains 40% Boyer soils, 20% Oshtemo soils, 10% Dresden soils, and 30% minor soils. Minor soils include Granby, Morocco, Plainfield, and Wyocena types.

Boyer soils are moderately deep, well-drained, nearly level to steep, sandy loams and loamy sands. They are moderately permeable and are underlain by rapidly permeable, calcareous, stratified sand and gravel. The available water capacity of this soil type is low.

Oshtemo soils are typically well-drained, nearly level to moderately steep, loamy sands to fine sandy loams. Underlying material consists of rapidly permeable, stratified sand with some gravel. The soils have moderately rapid permeabilities and low available water capacities.

Dresden soils consist of well-drained, gently sloping to moderately steep, loamy soils developed over stratified sand and gravel. They are characterized by moderate permeability and low available water capacity. The underlying sand and gravel are rapidly permeable.

The Houghton-Adrian-Palms association occupies depressional areas on outwash plains, ground moraines, and glacial lake basins. It generally occurs along major drainageways throughout the expanded study area. Elevations are typically between 750 and 800 feet msl. The association is characterized by nearly level topography and is subject to seasonally high groundwater levels and frequent ponding and flooding. It consists of approximately 50% Houghton soils, 30% Adrian soils, 10% Palms soils, and 10% minor soils. The most important minor soils are Boots soils, Alluvial land, and Marsh.

Houghton muck or peat consists of deep to very deep, very poorly drained, organic soils that overlie sandy, silty, or loamy lacustrine sediment. Soils of this series have moderately rapid permeabilities and high available water capacities.

Adrian muck or peat is composed predominantly of moderately deep, very poorly drained, organic soils underlain by lacustrine sand. Remains of vegetation typically are decomposed almost completely. The soils have moderately rapid permeabilities and high available water capacities.

Palms muck consists of poorly-drained, nearly level, organic soils underlain by loamy, mineralized soils. The available water capacities are high. Permeabilities are moderately rapid in the upper organic part and moderately slow in the lower mineralized part.

The Lapeer-Wyocena association occurs in the northern part of the expanded study area on undulating ground moraines, drumlins, and glaciated bedrock ridges. Bedrock ridges are composed of Cambrian sandstones (Olcott 1968) and have gently sloping tops and moderately steep to very steep sideslopes. Drumlins have an east-west orientation. Scattered stones and boulders occur throughout the area. Soils of this association are composed of approximately 40% Lapeer soils, 16% Wyocena soils, and 44% minor soils.

Lapeer soils consist largely of well-drained, gently sloping to steep, fine sandy loams formed in calcareous, sandy loam glacial till on till plains and drumlins. They are characterized by moderate permeability and medium available water capacity.

Wyocena soils are well-drained, gently sloping to very steep, sandy loams to loamy sands developed on glacial till. They generally have moderately rapid permeabilities and low available water capacities.

Less extensive soils in this association include Boyer, Marcellon, Military, Okee, Plainfield, and Rotamer soils. Boyer, Okee, and Plainfield soils occur mostly in valleys and along major drainageways. Marcellon soils occur along drainageways on the foot slopes of till uplands. Military soils occur on the crests and sides of sandstone ridges and Rotamer soils occur on drumlins.

The Plainfield-Okee association occurs in the western half of the expanded study area on rolling sandy outwash plains and on till plains and drumlins. The landscape is characterized by sand-capped drumlins separated by lower areas of sandy outwash. The sand is actively shifting and small blowouts are common. The association is comprised of approximately 50% Plainfield soils, 10% Okee soils, and 40% minor soils. Minor soils include Boone, Boyer, Lapeer, Oshtemo, and Wyocena soils.

Plainfield soils consist predominantly of excessively drained, nearly level to moderately steep sands and loamy sands developed on outwash sand. They are rapidly permeable and have low available water capacities. Loamy or silty material may occur locally at depths of 40 to 60 inches.

Okee soils are well-drained, gently sloping to moderately steep, loamy fine sands developed in sandy sediment (deposited by wind or water) overlying calcareous glacial till or till plains or drumlins. Okee soils generally have moderate to rapid permeabilities and medium available water capacities.

2.5. Groundwater Resources

2.5.1. Groundwater Availability

Although surface water is used for recreation, navigation, and wastewater disposal, the Portage area relies exclusively on groundwater for its water supply (Olcott 1968; Hindall and Borman 1974). Usable groundwater in the expanded study area exists in sand and gravel deposits in glacial drift and in the underlying sandstone bedrock. During 1977, the City of Portage pumped a total of 395,368,000 gallons, or 1,083,200 gallons per day (gpd), from the glacial drift aquifer and 102,862,000 gallons (281,813 gpd) from the sandstone bedrock aquifer (By telephone, Mr. Emil Abegglen, Portage Water Department, to Mr. Kent Peterson, WAPORA, Inc., 8 March 1978).

The primary water-bearing deposits in the glacial drift aquifer are lenses of sand and gravel in morainal deposits, lacustrine sand, and outwash deposits of sand and gravel. Well yields are highly variable and are dependent largely upon the thickness and lateral extent of the permeable deposit, the grain size and sorting of the sediment, and the diameter and construction of the well. Yields of small diameter wells in the expanded study area range from 8 gallons per minute (gpm) to 30 gpm, with a median yield of 20 gpm. Large diameter wells yield 1,065 gpm (Portage Well No. 3) and 540 gpm (Portage Cooperative Creamery Well).

Yields from moraines and lacustrine sediments are low, suitable only for domestic wells. Outwash deposits usually consist of permeable sands and gravels. Groundwater may occur under water table conditions in surficial deposits or under artesian conditions in buried outwash deposits. In preglacial bedrock valleys, large, continuous deposits of stratified sand and gravel may overlie the bedrock surface. These deposits comprise excellent aquifers that are capable of yielding large amounts of water to properly constructed wells.

In areas where permeable glacial drift deposits are thin or absent, wells penetrate the sandstone bedrock aquifer. In many instances, bedrock wells are preferred over glacial drift wells because they do not have to be screened and therefore are less expensive. Permeability in the sandstone is high and is produced by fractures, bedding planes, and pore spaces between sand grains. Well yields from small diameter wells range from 10 to 50 gpm, with a median value of 20 gpm. Large diameter wells yield 2,350 gpm (Portage Well No. 1) and 1,500 gpm (Portage Well No. 2).

2.5.2. Piezometric Levels

Water levels in wells indicate the position of the piezometric surface, which is a measure of hydrostatic pressure. In unconfined aquifers, this surface corresponds to the water table. The water table, however, does not follow the topography of the land exactly, because depths to groundwater generally increase with distance from major streams. An examination of well records (Table 2) and soil reports (US Soil Conservation Service 1971) indicated that depths to groundwater range from less than 5 feet in floodplains to more than 50 feet in upland areas.

Table 2. Well records for the Portage, Wisconsin, study area (Wisconsin Geological and Natural History Survey n.d.).

Township	Range	Section	Location	Owner	Driller	Completion Date	Aquifer	Well Diameter (in)	Elevation (ft msl)	Well Depth (ft)	Depth to Bedrock (ft)	Depth to Groundwater (ft)	Drawdown (ft)	Yield (gpm)	Length of Test (hrs)
12N	8E	1	SW¼ NE¼	Robert Bruce	Sam's Rotary Drillers, Inc.	1970	Pleistocene Gravel	6	840	156	---	62	28	30	3
12N	8E	2	NE¼ NE¼	William Rapp	Sam's Rotary Drillers, Inc.	1971	Cambrian Sandstone	6	820	95	62	26	12	20	2
12N	8E	2	NW¼ NW¼	William Sukolnik	Sam's Rotary Drillers, Inc.	1970	Cambrian Sandstone	6	800	80	60	3	37	13	2
12N	8E	12	NW¼ NE¼	Charles Monroe	Edward Marlisch	1967	Cambrian Sandstone	6	790	110	37	56	9	15	4
12N	9E	1	SW¼ SW¼	John Grimes	Sam's Rotary Drillers, Inc.	1967	Pleistocene Gravel	6	900	162	---	40	33	--	2
12N	9E	3	NE¼ NW¼	R. Clemens	Sam's Rotary Drillers, Inc.	1970	Pleistocene Sand Gravel	6	820	111	---	42	13	20	2
12N	9E	7	NW¼ NE¼	City of Portage Well No. 1	Layne-Northwest Co.	1949	Cambrian Sandstone	19	802	250	45	17	99	2,350	10
12N	9E	7	NE¼ NW¼	City of Portage Well No. 2	Layne-Northwest Co.	1949	Cambrian Sandstone	21	790	250	65	18	14	1,500	10
12N	9E	8	NW¼ NW¼	Portage Cooperative Creamery	George Reynolds & Son Drillers	1944	Pleistocene Sand	12	800	112	---	20	25	549	10
12N	9E	8	NW¼NE¼NW¼	Ray O Vac Corporation	George Reynolds & Son Drillers	1954	Pleistocene Sand & Gravel	10	790	132	---	18	--	---	--
12N	9E	12	NE¼ NW¼	Robert Evans	M. Halsen	1967	Cambrian Sandstone	6	800	180	91	7	13	15	14
12N	10E	6	NW¼	Robert Allen	Floyd Doris	1968	Pleistocene Sand & Gravel	4	800	80	---	14	9	20	9
13N	8E	14	NE¼ SW¼	J. D. Brown	Sam's Rotary Drillers, Inc.	1971	Cambrian Sandstone	6	840	106	81	55	17	20	2
13N	8E	35	NW¼ SW¼	Oakwood Trailer Court	M. Halsen	1968	Cambrian Sandstone	6	820	100	59	20	15	20	2
13N	8E	35	SW¼ SW¼	A. Price	Sam's Rotary Drillers, Inc.	1967	Cambrian Sandstone	6	802	70	60	4	10	20	2
13N	8E	35	SW¼ NE¼	Melvin Raddatz	Berkholtz Drilling Co., Inc.	1971	Cambrian Sandstone	6	800	171	166	12	6	20	1
13N	8E	36	SW¼ NW¼	Robert Doyal	Floyd Doris	1970	Pleistocene Sand & Gravel	4	820	64	---	28	2	20	2
13N	8E	36	SW¼ NE¼	Donald Sutfin	Sam's Rotary Drillers, Inc.	1972	Pleistocene Sand & Gravel	6	810	98	---	30	50	10	3
13N	9E	15	SW¼ SE¼	Ken Peterson	Sam's Rotary Drillers, Inc.	1968	Cambrian Sandstone	6	915	170	145	46	45	20	2
13N	9E	16	SW¼ NE¼	Kenneth Ramminger	Floyd Doris	1971	Pleistocene Sand & Gravel	4	800	60	---	20	3	15	4
13N	9E	16	NE¼ NE¼	Jules M. Rosenthal	M. Halsen	1967	Pleistocene Sand	6	820	102	---	50	8	20	24
13N	9E	8	SW¼ NW¼	Jerry McMahon Farm	Russell Cole	1940	Cambrian Sandstone	6	960	124	40	78	7	10	5
13N	9E	19	NW¼ SE¼	John Cimaroli	Sam's Rotary Drillers, Inc.	1971	Cambrian Sandstone	6	860	125	53	70	24	20	3
13N	9E	21	NE¼	Charles & Peter Verhurgt	Floyd Doris	1967	Pleistocene Sand & Gravel	7	800	77	---	20	9	20	8
13N	9E	22	SW¼ SE¼	Herbert Menke	Floyd Doris	1970	Cambrian Sandstone	7	900	185	151	50	8	50	10
13N	9E	22	SE¼ NW¼	Casmer Rucinski	Floyd Doris	1971	Pleistocene Sand & Gravel	4	820	76	---	35	5	10	5
13N	9E	24	NE¼ SE¼	Edmund Rapp	Sam's Rotary Drillers, Inc.	1969	Cambrian Sandstone	6	910	170	150	12	45	25	2
13N	9E	27	SE¼ SW¼	Don Lauterbach	Sam's Rotary Drillers, Inc.	1971	Cambrian Sandstone	6	790	235	223	10	19	15	2
13N	9E	29	NW¼ SE¼	John A. McMahon Farm	Tessen	1964	Cambrian Sandstone	12	790	80	65	8	--	--	--
13N	9E	31	SE¼ SW¼	City of Portage Well No. 3	Layne-Northwest Co.	1967	Pleistocene Sand & Gravel	34	820	125	---	32	36	1,065	6
13N	9E	11	SE¼ SE¼	Fort Winnebago Cemetery	Russell Cole	1940	Pleistocene Sand & Cambrian Sandstone	6	820	241	220	45	5	15	--
13N	9E	34	NW¼ SW¼	John Dryer	Vernon Hayen	1971	Pleistocene Sand	6	800	73	---	35	5	15	4
13N	9E	34	NW¼ NW¼	Henry Hanson	Sam's Rotary Drillers, Inc.	1966	Cambrian Sandstone	6	790	230	190	6	35	25	2
13N	9E	34	SE¼ SE¼	Bob Holmes	Sam's Rotary Drillers, Inc.	1973	Pleistocene Sand & Gravel	6	830	115	---	29	27	20	2
13N	9E	34	SE¼ SE¼	James Vetter	Sam's Rotary Drillers, Inc.	1971	Pleistocene Sand	6	830	111	---	52	57	9	2
13N	10E	30	SE¼ SE¼	Mr. Atkinson	Sam's Rotary Drillers, Inc.	1967	Cambrian Sandstone	6	940	190	90	42	11	20	2

2.5.3. Groundwater Quality

Water quality is similar in the bedrock and glacial drift aquifers (Table 3). Groundwater is typically hard and has a neutral to slightly basic pH. Groundwater temperatures range from 8.5°C to 12.5°C. Because the wells are relatively shallow, the large variation in temperature could reflect seasonal fluctuations. Groundwaters in the expanded study area can be classified as calcium-magnesium bicarbonate waters.

Groundwater quality problems in the expanded study area include hardness, locally high iron concentrations, and pollution from surface sources (Olcott 1968; Hindall and Borman 1974). Hardness and high iron concentrations primarily are related to natural geochemical processes and do not present serious problems. Groundwater may require softening and iron removal prior to domestic use.

Contamination from surface sources is the most serious groundwater quality problem. If aquifers are close to the surface, groundwater can be contaminated from surface sources (Olcott 1968). Such contamination also can occur if wells are not cased properly. The potential for contamination can be particularly high in floodplains, where the water table seasonally is high. Common types of pollutants are sewage discharges, industrial wastes, road salt, fertilizers, and pesticides.

High nitrate concentrations in well water usually indicate groundwater contamination from surface sources (Hem 1959; Walton 1970). Two of the samples show high nitrate concentrations (Table 3). One of these exceeds the USEPA water quality standard of 1C mg/l of nitrogen (N), or 44.26 mg/l as nitrate (NO_3), for domestic water supply.

2.6. Surface Waters

2.6.1. General Description

Portage is located between the Lower Wisconsin River Basin and the Fox-Wolf River Basin. The Wisconsin River and the Fox River are within 1.5 miles of each other at Portage. The Wisconsin River flows to the Mississippi River Basin, and the Fox River flows to the Great Lakes (Figure 1).

The Wisconsin River Basin is located primarily in the central area of Wisconsin, lying generally north and south from upper Michigan to Portage and east-west from Portage to the Mississippi River. The drainage area of the entire Basin is 11,730 square miles, of which 7,940 square miles are north of Portage. The Wisconsin River is the largest river in the state, 430 miles long. The Lower Wisconsin River Basin, in which Portage is located, includes an area of approximately 3,780 square miles, which contains all or parts of 11 counties in southwestern Wisconsin. The nearest downstream impoundment is Lake Wisconsin, about 12 miles south of Portage. The Baraboo River, with a drainage area of 650 square miles, is the only major tributary near the Portage study area.

The Fox-Wolf River Basin drains an area of approximately 6,500 square miles in east-central and northeastern Wisconsin. The Basin includes all or significant parts of 18 counties. The headwaters of the

Table 3. Groundwater quality in the Portage, Wisconsin, study area (USGS n.d.).

Township	Range	Section	Owner	Aquifer	Total Dissolved Solids (mg/1)	Alkalinity ($CaCO_3$) (mg/1)	Hardness ($CaCO_3$) (mg/1)	Temperature (°C)	Specific Conductance (mhos)	pH (units)	Silica (SiO_2) (mg/1	Calcium (Ca^{++}) (mg/1)	Magnesium (Mg^{++}) (mg/1)	Sodium (Na^+) (mg/1)	Potassium (K^+) (mg/1)
12N	09E	7	Portage Well No. 1	Cambrian Sandstone	331	249	280	11.5	537	7.2	15	63	30	12	2.5
12N	09E	7	Portage Well No. 2	Cambrian Sandstone	246	181	220	12.5	412	7.4	14	48	24	9.2	2.0
12N	09E	8	------------------	Cambrian Sandstone	236	204	230	10.5	394	7.8	15	50	26	2.9	0.9
12N	09E	12	Miller Thurston	Cambrian Sandstone	223	184	190	11.0	380	7.7	16	38	24	2.8	2.2
13N	08E	11	Thomas Zwettler	Cambrian Sandstone	270	254	280	11.0	530	6.9	7.9	61	32	0.8	0.7
13N	08E	12	George Johnston	Cambrian Sandstone	160	80	110	10.5	250	6.9	12	23	12	2.0	1.8
13N	09E	15	Rodney Gifford	Cambrian Sandstone	274	178	200	8.5	440	7.5	17	42	23	2.1	0.8
13N	09E	16	Kenneth Raminger	Pleistocene Sand & Gravel	326	212	260	10.0	580	7.8	18	58	29	1.8	0.7
13N	09E	31	Portage Well No. 3	Pleistocene Sand & Gravel	248	186	216	----	---	7.6	--	49	22	2.4	---

Township	Range	Section	Owner	Aquifer	Total Iron (Fe) (mg/1)	Manganese (Mn) (mg/1)	Ammonia (NH_4^+) (mg/1)	Sulfate ($SO_4^=$) (mg/1)	Chloride (Cl^-) (mg/1)	Fluoride (F^-) (mg/1)	Nitrate (NO_3^-) (mg/1)	Nitrite (NO_2^-) (mg/1)	Total Phosphorous (P) (mg/1)	Carbon Dioxide (CO_2) (mg/1)
12N	09E	7	Portage Well No. 1	Cambrian Sandstone	*0.32	0.34	----	26	23	0.1	2.4	0.00	0.02	31
12N	09E	7	Portage Well No. 2	Cambrian Sandstone	*0.22	0.32	----	27	17	0.3	4.1	0.00	0.01	14
12N	09E	8	------------------	Cambrian Sandstone	*0.01	0.03	----	20	2.3	0.3	6.1	0.10	0.02	6.3
12N	09E	12	Miller Thurston	Cambrian Sandstone	1.00	0.02	0.00	14	1.1	0.1	0.00	0.00	0.01	7.2
13N	08E	11	Thomas Zwettler	Cambrian Sandstone	0.02	0.01	0.00	16	1.5	0.1	3.2	0.00	0.01	62
13N	08E	12	George Johnston	Cambrian Sandstone	0.06	0.01	0.00	31	1.9	0.0	0.80	0.00	0.01	20
13N	09E	15	Rodney Gifford	Cambrian Sandstone	0.10	0.01	0.00	14	0.9	0.1	20	0.00	0.00	11
13N	09E	16	Kenneth Raminger	Pleistocene Sand & Gravel	0.12	0.01	0.00	13	5.7	0.1	49	0.00	0.01	6.5
13N	09E	31	Portage Well No. 3	Pleistocene Sand & Gravel	0.03	0.04	----	15	3.0	0.2	3.5	0.10	----	----

* Values represent dissolved iron.

Fox River are located in northeastern Columbia County. There are no significant tributaries to the Fox River within the study area. Upstream of Portage, the Fox River has a drainage area of 900 square miles. Downstream from Portage the Fox River flows generally northeast through a series of lakes and impoundments to Green Bay, Wisconsin, on Lake Michigan. Buffalo Lake is the impoundment closest to Portage on the Fox River, approximately 20 miles downstream (north). In the Portage area, the Fox River usually is about 6 feet lower during normal flood stages than the Wisconsin River.

2.6.2. Wisconsin River Hydrology

The flow of the Wisconsin River near Portage is measured by the USGS at two locations on a continuing basis. One gaging station is located approximately 15 miles upstream from Portage and has a period of record from October 1934 to the current year. The drainage area upstream from the Wisconsin Dells gaging station is 7,830 square miles. The gage records can be assumed to approximate the flow of the Wisconsin River near Portage due to the relatively close location and the absence of any major tributaries entering the Wisconsin River. The other gaging station is located at Muscoda, 70 miles downstream from Portage. The drainage area upstream from Muscoda is 10,300 square miles. This gaging station has a period of record from October 1913 to the present. A summary of the records for each gaging station is presented in Table 4.

Table 4. Summary of flow data for the Wisconsin River (USGS 1977a). Discharges are given in cubic feet per second (cfs).

	Near Wisconsin Dells	Near Muscoda
Average discharge (period of record)	6,775	8,625
Extremes for period of record		
Maximum discharge	72,200	80,800
Minimum discharge	1,060	2,000
Extremes for 1975-1976 water year		
Maximum discharge	41,000	46,700
Minimum discharge	1,500	2,290

The annual flow information from both stations for the past 15 years is presented in Table 5. Monthly summaries of flow for the 1975-1976 water year (USGS 1978) are given in Table 6. Monthly summaries of flow for the 1976-1977 and 1977-1978 water years are given in Appendix D, Tables D-1 and D-2. These monthly records illustrate the typical seasonal variations in flow, which correspond to low flows during late summer and autumn and to high flows during the spring.

During June, July, August, and September 1978, USEPA collected river flow measurements on the Fox River, the Wisconsin River, and the Baraboo River. The data for the Wisconsin River and the Baraboo River are presented in Table 7. These values are higher than those collected by the USGS during the 1975-1976 water year, which appear to approximate average

Table 5. Wisconsin River flow records for water years 1962-1977 (USGS 1977a). Discharges are given in cubic feet per second (cfs).

Water Year	Wisconsin Dells Gaging Station Mean	Maximum	Minimum	Muscoda Gaging Station Mean	Maximum	Minimum
1962	7,196	29,200	2,400	9,694	34,200	3,900
1963	5,316	21,100	1,890	6,781	22,000	2,950
1964	3,694	15,500	1,300	4,802	17,500	2,290
1965	7,345	46,600	2,300	8,831	46,900	3,200
1966	7,408	32,600	2,000	9,634	32,300	3,380
1967	6,769	51,200	2,340	8,437	51,200	3,420
1968	7,643	39,300	1,500	9,216	41,600	3,200
1969	7,978	44,700	2,730	10,180	44,800	4,140
1970	4,661	24,200	2,000	6,625	24,800	3,390
1971	7,194	35,400	2,500	9,131	38,300	4,010
1972	8,065	43,200	2,980	9,768	47,700	4,090
1973	12,420	61,900	3,510	16,030	64,600	5,160
1974	5,669	26,700	2,760	8,411	29,200	5,070
1975	5,765	35,800	2,010	8,588	42,100	3,700
1976	7,166	40,400	1,570	9,219	46,600	2,320
1977	2,993	8,310	1,300	4,127	9,590	1,900

Table 6. Wisconsin River flows during the 1975-1976 water year (USGS 1977b). Discharges are given in cubic feet per second (cfs).

Month	Wisconsin Dells Gaging Station Mean	Maximum	Minimum	Muscoda Gaging Station Mean	Maximum	Minimum
October	3,861	5,200	3,100	5,117	6,650	3,900
November	6,146	12,000	3,200	7,920	13,200	4,530
December	7,333	9,980	5,000	9,386	12,600	5,800
January	5,516	6,200	4,500	6,755	7,800	5,200
February	6,640	9,770	5,000	8,634	12,000	6,200
March	13,250	38,800	8,600	16,120	32,300	11,000
April	22,440	40,400	10,500	28,610	46,600	15,500
May	9,015	13,700	5,330	12,190	18,700	8,400
June	4,674	6,500	3,560	6,083	8,600	4,500
July	2,866	3,720	2,560	3,829	5,000	3,260
August	2,662	3,280	2,370	3,591	4,640	3,140
September	1,752	2,350	1,570	2,651	3,200	2,320

flow conditions during the previous 15 years. The 7-day, 10-year low flow for the Wisconsin River at Portage was determined by WDNR (McKersie 1977) through interpolation of USGS gaging station records at Wisconsin Dells, Muscoda, and Baraboo. The 7-day, 10-year low flows determined by WDNR for these stations were 1,800 cfs, 2,260 cfs, and 84 cfs, respectively. The 7-day, 10-year flow for the Wisconsin River at Portage was determined to be 1,850 cfs.

Table 7. Wisconsin River and Baraboo River flow data for 1978 (USEPA 1979a). Discharges are given in cubic feet per second (cfs).

	June	July	August	September
Wisconsin River	10,015	10,860	5,110	11,952
Baraboo River	276	1,531	220	256

2.6.3. Fox River Hydrology

The USGS continuous gaging station nearest to Portage is at Berlin, Wisconsin. The gaging station is located approximately 60 miles downstream from Portage and has a period of record from January 1898 to the current year. The drainage area upstream from the gaging station is approximately 1,430 square miles. A summary of the records is presented in Table 8. The annual flow information for the past 15 years is presented in Table 9. A monthly summary of flow for the water year 1975-1976 is presented in Table 10. These monthly records illustrate the typical seasonal variations in flow. Because of the difference between the size of the drainage basin at Portage and the size of the basin at Berlin, the information given in Tables 8, 9, and 10 cannot indicate accurately the flow of the Fox River at Portage.

During June, July, August, and September 1978, USEPA made river flow measurements on the Fox River upstream and downstream from the WWTP at Portage (Table 11). These data cannot be compared to the data collected at Berlin, Wisconsin, and no other data are available to validate the USEPA measurements. To obtain the 7-day, 10-year low flow for the Fox River, WDNR contracted with the USGS to monitor the River near the Portage WWTP. Data were collected during August, September, and November 1972 and during July and August 1973. These data were interpolated through the use of the Berlin, Wisconsin, gaging station data. The 7-day, 10-year low flow at Portage was 15 cfs. During August 1977, two additional flow surveys were conducted by WDNR at the Route 33 Bridge, approximately 200 yards downstream from the WWTP. The surveys indicated flows of 14.26 cfs and 17.7 cfs, respectively. These figures were interpolated to upstream flows of 11.6 cfs and 15.0 cfs, respectively. (By telephone, Mr. Jerome McKersie, WDNR, to Ms. Carol Qualkinbush, WAPORA, Inc., March 1977).

Table 8. Summary of flow data for the Fox River near Berlin, Wisconsin (USGS 1977b). Discharges are given in cubic feet per second (cfs).

Average discharge (period of record)	1,093
Extremes of period of record	
Maximum discharge	6,900
Minimum discharge	248
Extremes for 1975-1976 water year	
Maximum discharge	3,420
Minimum discharge	355

Table 9. Fox River flow records for water years 1962-1977 at Berlin, Wisconsin (USGS 1978). Discharges are given in cubic feet per second (cfs).

Water Year	Mean	Maximum	Minimum
1962	1,407	5,140	553
1963	808	3,460	382
1964	559	1,420	321
1965	813	2,730	327
1966	1,417	3,100	420
1967	749	2,960	355
1968	885	1,960	450
1969	1,023	2,800	411
1970	709	1,640	335
1971	1,103	4,200	376
1972	1,075	3,420	504
1973	2,078	5,970	652
1974	1,379	3,000	648
1975	1,180	4,100	391
1976	1,079	3,420	360
1977	609	1,870	320

Table 10. Fox River flows during the 1975-1976 water year at Berlin, Wisconsin (USGS 1977b). Discharges are given in cubic feet per second (cfs).

Month	Mean	Maximum	Minimum
October	509	716	544
November	746	1,110	636
December	1,112	1,350	990
January	631	1,000	560
February	1,024	2,650	560
March	2,215	3,380	1,570
April	2,840	3,420	2,330
May	1,815	2,660	1,000
June	676	990	501
July	459	522	400
August	489	552	410
September	385	431	360

Table 11. Fox River flow data for 1978 (USEPA 1979b). Discharges are given in cubic feet per second (cfs).

	June	July	August	September
Upstream from WWTP	40.63*	90.67	25.18	76.06
Downstream from WWTP	28.82*	99.38	25.73	71.18

* It is the opinion of USEPA that this figure is not valid.

2.6.4. Surface Water Use

As a major surface water resource, the Wisconsin River presently is used as the receiving water for wastewater effluent, for water supply, and for recreation. It assimilates and disperses both human and industrial wastes discharged from municipal and industrial point sources (Section 2.6.5.5.). The Wisconsin River also serves the water needs of industry and commerce. The largest user of surface water in the Lower Wisconsin will be the Badger Army Ammunition Plant near Baraboo, scheduled to begin operation soon. It is anticipated to use 11.7 mgd of water from the Wisconsin River. Approximately 85% of this water will be returned to the River, with very little change in chemical quality. Irrigation use is increasing in the area. The total quantity of surface water consumed by category of use is listed in Appendix D, Table D-3. Fourteen percent of the water consumed in the Basin is from surface water, excluding recent increases in surface water use for irrigation.

The lower part of the Wisconsin River is used for recreation, especially canoeing. The Federal Government tentatively has recommended that the lower part of the Wisconsin River be included as a State-administered component of the National Wild and Scenic Rivers System (Hindall and Borman 1974).

The Fox River near Portage has potential for recreational use. However, current recreational use is minimal. In the vicinity of Portage, the Fox River is used primarily as the receiving water for municipal wastewater effluent (Olcott 1968).

2.6.5. Water Quality

2.6.5.1. Water Quality Standards

The quality of the Wisconsin River and the Fox River is regulated by WDNR through Chapter 144 of the Wisconsin Statutes and Chapters 102 and 104 of the Wisconsin Administrative Code. These standards apply to each river according to its use and location. Present (1978) standards are divided into four categories: general standards, standards for fish and aquatic life, standards for recreational use, and standards for public water supply (Appendix D, Table D-4). A summary of State standards

(State of Wisconsin 1973) and Federal recommendations (USEPA 1972; 1976c) for selected, pertinent parameters is given below:

Parameter	State Standard	Federal Recommendation
Fecal coliform (MPN/100 ml)	200	200
Dissolved oxygen (mg/l)	5.0	5.0
Total phosphorus (mg/l)	NA	0.10, 0.05
Nitrate-nitrogen (mg/l)	NA	10
Mercury (micrograms per liter [ug/l])	NA	0.05

NA - Not applicable.

The standards and recommendations for these parameters are based on criteria to protect various water uses and/or aquatic resources: fecal coliform -- full-body contact recreation; dissolved oxygen (DO) -- freshwater aquatic life; total phosphorus -- free-flowing stream or river (0.10 mg/l), and stream or river that enters an impoundment or lake (0.05 mg/l); nitrate-nitrogen -- domestic water supply; and mercury -- freshwater aquatic life and wildlife.

2.6.5.2. Wisconsin River

The Wisconsin River at Portage is "effluent limited". The stream is capable of meeting water quality goals with the application of basic treatment technology to wastewater effluent. WDNR has stated that water quality goals for 1983 are being met on the lower part of the Wisconsin River. However, this does not mean that violations of the standards do not occur. It means that the water quality of the lower part of the Wisconsin River generally meets criteria (WDNR 1977c).

WDNR maintains surface water quality stations at the Wisconsin Dells, 15 miles upstream from Portage, and at Prairie du Sac, approximately 21 miles downstream from Portage. Water quality data for the Wisconsin River at the Wisconsin Dells have been gathered monthly since 2 February 1977. No USGS surface water quality station is located upstream from Portage. The closest USGS surface water quality station downstream from Portage is at Muscoda. None of the available data, however, reflect accurately the water quality conditions at Portage and at the point of entry into Lake Wisconsin.

Fecal coliform, dissolved oxygen and nitrate-nitrogen levels were within standards set by the State of Wisconsin and standards recommended by USEPA (Table 12). Concentrations of total phosphorus were relatively high, and mercury concentrations were recorded at levels higher than the level that is recommended by USEPA (1976c). Total phosphorus concentrations should measure 0.10 mg/l in a moving stream or river and should be less than 0.05 mg/l in a stream or river at the point where it enters a lake or impoundment. The latter recommendation is intended to ensure that the rate of eutrophication will not increase. Total phosphorus concentrations exceeded the Federal recommendation of 0.10 mg/l twice during 1977 and four times during the first 11 months of 1978. All concentrations at the point of entry into Lake Wisconsin exceeded the 0.05 mg/l recommendation. The concentrations observed are an indication

Table 12. Water quality data for the Wisconsin River at Wisconsin Dells (WDNR 1978, 1979a).

Date	Total Phosphorus (mg/l)	Fecal Coliform (MPN/100 ml)	Dissolved Oxygen (mg/l)	Nitrate-Nitrogen (mg/l)	Mercury (ug/l)
2-28-77	0.100	300*	10.0	0.3	<0.2
3-22-77	0.070	<10	7.7	0.2	<0.3
4-20-77	0.090	<10	9.2	0.2	<0.2
5-17-77	0.070	30	7.5	0.3	<0.2
6-20-77	0.110**	40	9.2	0.1	<0.2
7-25-77	0.120**	20	8.3	0.01	<0.2
9-13-77	0.080	<10	8.5	0.02	<0.2
10-12-77	0.080	60	10.4	0.2	<0.2
11-15-77	0.080	450*	12.9	0.5	<0.2
12-13-78	0.060	190	11.8	0.5	<0.2
1-12-78	0.180**	50	10.6	0.6	<0.2
2-08-78	0.080	50	10.8	0.7	<0.2
3-09-78	0.08	80	9.3	--	<0.2
4-12-78	0.12**	<10	12.4	0.6	<0.2
5-09-78	0.08	<10	10.4	0.5	<0.2
6-12-78	0.08	10	8.2	0.3	<0.2
7-10-78	0.14**	50	7.6	0.5	<0.2
8-10-78	0.12**	50	7.2	0.1	--
9-21-78	--	80	7.4	--	<0.2
10-11-78	0.10	50	9.7	0.4	<0.2
11-08-78	--	20	--	--	--

*Potentially violates USEPA recommended standards (USEPA 1976c).

**Violates USEPA recommended standards (USEPA 1976c).

of the presence of phosphorus in the Wisconsin River. It is recommended that mercury concentrations not exceed 0.05 ug/l to protect freshwater aquatic life and wildlife. Mercury concentrations in the Wisconsin River at the Wisconsin Dells averaged less than 0.2 ug/l during 1978. The actual mercury concentration cannot be determined by the instruments that are presently being used by WDNR.

During June, July, and August 1971, a sampling program was conducted that included eight sampling sites in the reach of the River between the Wisconsin Dells and the Merrimac Ferry (WDNR 1972b). The results of this 8-year old study, however, do not reflect the present condition of the Wisconsin River. Phosphorus and nitrogen concentrations in the River were not measured during the study.

During June, July, August, and September 1978, USEPA collected water quality data for the Wisconsin River at three locations (USEPA 1979b):

- Approximately 1.0 mile upstream from Portage

- Downstream from Portage, approximately 2.0 miles downstream from the Route 33 Bridge

- Approximately 7.0 miles downstream from Portage, near the public landing at Dekorra, and downstream from the confluence of the Baraboo River and the Wisconsin River.

These data reflect water quality conditions in the Wisconsin River near Portage and also near the entry point into Lake Wisconsin. The water quality sampling stations are illustrated in Appendix D, Figure D-1. Water samples were collected once each month. Sediment samples were collected only during June and September.

The water quality data collected are presented in Table 13. Total phosphorus, fecal coliform, manganese (Mn), and iron (Fe) concentrations consistently exceeded State of Wisconsin standards and/or USEPA recommended concentrations (State of Wisconsin 1973; USEPA 1972, 1976c). At the upstream and midstream stations, total phosphorus concentrations exceeded 0.10 mg/l during July, August, and September. This indicates that total phosphorus may be a problem regardless of the phosphorus loadings from Portage. Total phosphorus concentrations at the downstream station exceeded the 0.05 mg/l recommendation during all 4 months. The fecal coliform standard for Wisconsin (State of Wisconsin 1973) and the Federal recommendation (USEPA 1976c) potentially were exceeded at all three stations at least twice during the 4-month period. Fecal coliform counts at the three stations ranged from 0.50 to 460 MPN/100 ml at the upstream station, 0.79 to 460 MPN/100 ml at the midstream station, and 0.49 to 1,300 MPN/100 ml at the downstream station. Manganese concentrations were higher than the recommended 5 ug/l for public water supply sources (USEPA 1976c) at all stations during July and August. These concentrations ranged from 143 ug/l to 193 ug/l at each station. Iron concentrations exceeded the recommended concentration of 1.0 mg/l for all samples collected. Concentrations of iron ranged from 1.10 mg/l to 1.67 mg/l. Mercury concentrations were consistently less than 0.1 ug/l at all stations during the monitoring period. Dissolved oxygen concentrations

Table 13. Water quality data for the Wisconsin River (USEPA 1979b).

Parameter	Upstream from Portage June	Upstream from Portage July	Upstream from Portage August	Upstream from Portage September	Downstream from Portage June	Downstream from Portage July	Downstream from Portage August	Downstream from Portage September	Downstream from Portage, near DeKorra June	Downstream from Portage, near DeKorra July	Downstream from Portage, near DeKorra August	Downstream from Portage, near DeKorra September
NO_3-NO_2 (mg/l)	0.36	0.50	0.07	0.17	0.36	0.59	0.08	0.17	0.59	0.31	<0.03	0.77
NH_3 (mg/l)*	0.09	0.06	0.05	0.03	0.08	0.08	0.03	<0.03	0.06	0.07	0.03	0.80
TKN (mg/l)	0.90	1.26	0.87	0.77	0.75	1.02	0.82	0.80	0.80	1.07	0.82	0.83
Total phosphorus (mg/l)	0.06	0.13**	0.12**	0.16**	0.06	0.12 *	0.11**	0.11**	0.06**	0.14**	0.11**	0.38**
BOD_5 (mg/l)	>2.0	3.0	3.00	>2.00	2.1	4.40	3.0	<2.0	2.8	2.6	3.0	2.00
Fecal coliform (MPN/100ml)	50.0	460.0**	55.00	230.00	80.0	350.00**	460.0**	79.0	50.0	310.0**	1,300.0**	49.00
Dissolved oxygen (mg/l)	7.2	5.8	7.00	7.55	6.3	6.10	NC	7.8	6.6	3.8**	7.5	7.65
Temperature (^{o}C)	20.0	21.0	22.00	20.00	20.0	20.00	22.0	20.0	22.0	21.0	22.0	20.00
Fluoride (mg/l)	0.3	0.2	0.124	4.06	0.4	0.058	0.104	0.087	0.9	0.08	NC	0.077
Cd (ug/l)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Cr (ug/l)	<5.0	20.0	<5.0	6.0	7.0	27.0	<5.0	<5.0	6.0	15.0	<5.0	6.0
Cu (ug/l)	<6.0	8.0	8.0	<6.0	<6.0	8.0	<6.0	<6.0	<6.0	7.0	8.0	<6.0
Fe (ug/l)	1,100.0**	1,540.0**	1,520.0**	1,550.0**	1,250.0**	1,590.0**	1,670.0**	1,570.0**	1,170.0**	1,230.0**	1,660.0**	1,540.0**
Mn (ug/l)	70.0	144.0**	143.0**	145.0**	74.0	150.0**	155.0**	149.0**	82.0	193.0**	165.0**	163.0**
Ni (ug/l)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Pb (ug/l)	<20.0	27.0	<20.0	<20.0	28.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Zn (ug/l)	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0
As (ug/l)	2.0	3.5	<2.0	7.7	<2.0	4.8	<2.0	5.5	<2.0	7.6	<2.0	<2.0
Hg (ug/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NC	<0.1	<0.1	<0.1
Aroclor 1242 (ug/l)	<0.5	<0.5	0.7	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aroclor 1248 (ug/l)	<0.5	<0.1	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5
Aroclor 1254 (ug/l)	<1.0	<1.0	<0.1	<0.1	<1.0	<1.0	<0.1	<0.1	<1.0	<1.0	<0.1	<0.1
Aroclor 1260 (ug/l)	<1.0	<1.0	<0.1	<0.1	<1.0	<1.0	<0.1	<0.1	<1.0	<1.0	<0.1	<0.1
Aldrin (ug/l)	<0.01	<0.5	<0.1	<0.1	<0.01	<0.5	<0.1	<0.1	<0.01	<0.5	<0.5	<0.1

*Values for NH_3 actually represent concentrations of total ammonia as nitrogen (By telephone, Mr. Wayne Kaiser, USEPA Western District Office, to Ms. Catherine Garra, USEPA Region V, 17 September 1979).

**Not within recommended Federal criteria for pollution control (USEPA 1972, 1976).

NC - Not collected.

ranged from 3.8 mg/l to 7.6 mg/l. The 5.0 mg/l minimum concentration was violated once at the downstream station during July (State of Wisconsin 1973; USEPA 1976c). The recommended fluoride concentration was exceeded upstream from Portage in September.

Polychlorinated biphenyls (PCBs), a group of industrial chemicals previously used extensively in manufacturing processes and consumer products, are present in the Wisconsin River. PCB concentrations are given in Table 13 under the trade name Aroclor. The degree of chlorination determines their chemical properties, and generally their composition can be identified by the numerical nomenclature. The first two digits represent the molecular type and the last two digits the average percentage by weight of chlorine (e.g., Aroclor 1242). Total levels of PCBs usually are derived from adding the individual Aroclor levels to obtain a single total. Exact measurements are not available, because the measuring instruments were not sensitive to the present concentrations in the River.

2.6.5.3. Lake Wisconsin

Lake Wisconsin was included in the National Eutrophication Survey that was initiated in 1972 (USEPA 1973). The survey of Lake Wisconsin, conducted by USEPA and WDNR, was designed to collect information on nutrient sources and concentrations and the impacts of those concentrations on selected freshwater lakes. The information was to serve as a basis for the development of comprehensive and coordinated national, regional, and state management programs for point source discharge reduction and nonpoint source pollution containment in lake watersheds.

Eutrophication is the normally slow aging process by which a lake evolves from an open water habitat to a bog or marsh and ultimately to a completely terrestrial habitat. During eutrophication, a lake becomes enriched with nutrients, especially nitrogen and phosphorus. Algae and other plant life become abundant, "choking" the lake and causing it to dry up eventually. Lakes are classified as oligotrophic (deficient in plant nutrients), mesotrophic (having a moderate amount of dissolved nutrients), or eutrophic (rich in dissolved nutrients and usually deficient in dissolved oxygen). Human activities often can increase the rate of eutrophication.

During 1978, the average total phosphorus concentration in the Wisconsin River near Portage and upstream from Lake Wisconsin was approximately 0.10 mg/l. This concentration represents the maximum amount of total phosphorus indicative of a clean stream. It is recommended that total phosphorus concentrations in non-eutrophic lakes should be less than 0.025 mg/l, and that streams and rivers that flow into impoundments or lakes should have concentrations of 0.05 mg/l or less of total phosphorus (USEPA 1972; By telephone, Mr. Jerome McKersie, WDNR, to Ms. Carol Qualkinbush, WAPORA, Inc., March 1978). The Wisconsin River contributes 93% of the inflow to Lake Wisconsin, and Lake Wisconsin has a mean hydraulic retention time of only four days. Therefore, it is highly unlikely that the total phosphorus concentration in Lake Wisconsin could ever be less than 0.025 mg/l. An examination of Wisconsin River water quality data (USEPA 1973) indicated that total phosphorus concentrations ranged from 0.052 mg/l to 0.15 mg/l and averaged 0.07 mg/l.

The average annual total phosphorus loading for Lake Wisconsin was estimated during the USEPA lake eutrophication study to be 15.21 grams/m^2/day. The recommended Vollenweider loading rate for phosphorus (based on the mean depth and mean hydraulic retention time of Lake Wisconsin) that would maintain a clean, oligotrophic lake is 1.25 grams/m^2/ day. The "dangerous" loading rate that would cause eutrophication was determined to be 2.50 grams/m^2/day (USEPA 1974b). Thus, the existing incoming total phosphorus load is more than six times the loading rate known to cause lake eutrophication (USEPA 1972).

From the data collected in June, July, and November 1972, it was concluded that nitrogen was the critical nutrient limiting plant productivity (thus the rate of eutrophication) during June and July, and that phosphorus was the critical nutrient limiting productivity during November (USEPA 1973). Although the study concluded that Lake Wisconsin is eutrophic, WDNR stated that, due to the area limitations of the survey, a broader scope is needed to assess the effectiveness of point source phosphorus control in the drainage area (By telephone, Mr. Jerome McKersie, WDNR, to Ms. Carol Qualkinbush, WAPORA, Inc., March 1978).

Water quality parameters were measured by USEPA during June, July, August, and September 1978 at a sampling site located downstream from Portage near the public landing at Dekorra (Table 13). Total phosphorus concentrations ranged from 0.06 mg/l in June to 0.38 mg/l in September, exceeding the Federal recommendation (USEPA 1972) for streams and rivers that flow into impoundments or lakes. These total phosphorus concentration levels in the Wisconsin River at the point of entry into Lake Wisconsin are higher than the level required to maintain an oligotrophic lake.

2.6.5.4. Fox River

WDNR has designated the Upper Fox River as "effluent limited". The Upper Fox River generally meets Wisconsin water quality standards (1983 water quality goals). However, information in a WDNR water quality inventory (WDNR 1977c) indicated that the River is very eutrophic and has severe aesthetic problems, which are caused by a combination of factors such as agricultural runoff, WWTP effluent, and impoundments.

No consistent sampling has been done on the Fox River near Portage by either USGS or WDNR. Twelve monthly water quality samples were taken at Marcellon during 1973 and 1974 (WDNR 1974). The results indicated that dissolved oxygen standards are being met. The sampling was conducted upstream from Pardeeville and Portage, the locations of two point sources in the Fox River headwaters subbasin.

A preliminary waste load allocation study was conducted by WDNR on 6 and 7 September 1977 (WDNR 1977b). The results of the study reflected the water quality of the Fox River for only one day during low flow conditions (16.06 cfs upstream from the treatment plant outfall). These data may or may not be representative of the quality of the Fox River. The locations of the water quality sampling stations are shown in Appendix D, Figure D-1.

During the allocation study, WDNR recorded field observations at intervals of several hundred feet along the stream reach from just upstream from the WWTP to 2.15 miles downstream from the effluent outfall. The DO levels measured ranged from 1.85 mg/l upstream from the outfall to 0.9 mg/l at a point 2.1 miles downstream from the outfall (Appendix D, Figure D-2). An examination of the data indicated that DO recovery occurred within 1.0 mile of the outfall. Dissolved oxygen levels varied significantly during the day, which indicates the presence of a large algal population on that particular day (Appendix D, Figure D-3).

WDNR also collected chemical data from five stations, all located close to the wastewater treatment effluent outfall (Table 14). Concentrations of nitrogenous compounds and total phosphorus increased downstream, which could be due to the WWTP discharge (Section 3.5.). The significance of the in-stream increase in nitrogenous compounds is hard to assess because of the small area sampled and the lack of nonpoint source information. An excess of nitrogen in the water would tend to promote plant productivity and thus eutrophication, if phosphorous were readily available. The phosphorus loading of the effluent exceeded the standard of 1.0 mg/l for streams flowing into the Great Lakes. Excess plant growth was noted in the section of the Fox River in the study area.

Table 14. Chemical data from the WDNR Fox River study (WDNR 1977b).

Station No.	Distance from Outfall (miles)	BOD_{20}	Total Org. N	NH_3-N	NO_2-N + NO_3-N	Total P
1	0.1	9	0.6	0.03	0.02	0.03
2	0.0	64	2.3	6.2	4.44	5.9
3	0.04	10.5	--	0.25	0.16	0.44
9	0.5	10.5	0.9	0.24	0.24	0.38
27	1.5	10.4	0.9	0.10	0.48	0.45
Trib. 1	0.55	16.8	0.8	0.16	0.05	0.13
Trib. 2	1.02	11.5	0.8	0.13	0.34	0.42
Trib. 3	2.15	10.5	0.6	0.11	1.56	0.09

During June, July, August, and September 1978, USEPA collected water quality data from two locations on the Fox River (USEPA 1979b). Data were collected 500 feet upstream from the wastewater treatment plant outfall and 500 feet downstream from the wastewater treatment plant. The locations of these stations are illustrated in Appendix D, Figure D-1. Sediment samples from the above locations were collected, as well as effluent and sludge samples from the wastewater treatment plant. Sediment samples were collected during June and September. All other samples were collected monthly.

Concentrations of total phosphorus, fecal coliform, DO, mercury, and fluoride exceeded Federal recommendations and/or Wisconsin standards (Table 15). Total phosphorus concentrations in samples from the upstream station ranged from 0.05 mg/l to 0.10 mg/l, and ranged from 0.15 mg/l to

Table 15. Water quality data for the Fox River (USEPA 1979b).

Parameter	Upstream from Wastewater Treatment Plant				Downstream from Wastewater Treatment Plant			
	June	July	August	September	June	July	August	September
NO_3-NO_2 (mg/l)	0.13	0.03	0.07	<0.03	0.13	0.06	0.46	0.13
NH_3 (mg/l)*	0.08	0.10	0.08	0.04	0.48	0.23	0.23	0.12
TKN (mg/l)	0.67	1.05	0.74	1.29	1.35	1.21	1.01	1.38
Total phosphorus (mg/l)	0.09	0.10	0.05	0.10	0.25**	0.18**	0.15**	0.22
BOD_5 (mg/l)	<2.0	<2.0	<2.0	3.0	3.5	<2.0	4.0	3.0
Fecal coliform (MPN/100ml)	11.0	220.0**	23.0	490.0**	23.0	2.4×10^6**	49.0	3,300.0**
Dissolved oxygen (mg/l)	2.0**	3.2**	2.6**	4.2**	3.6**	3.5**	1.65**	4.15**
Temperature (°C)	18.0	21.0	23.0	19.0	18.0	20.0	23.0	19.0
Fluoride (mg/l)	0.2	0.086	0.37	0.098	5.2	0.068	0.21	0.084
Cd (ug/l)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Cr (ug/l)	17.0	15.0	18.0	15.0	17.0	16.0	18.0	18.0
Cu (ug/l)	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	7.0	<6.0
Fe (ug/l)	<170.0	310.0	<170.0	178.0	<170.0	283.0	<170.0	260.0
Mn (ug/l)	90.0	85.0	30.0	49.0	99.0	76.0	27.0	53.0
Ni (ug/l)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Pb (ug/l)	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	35.0
Zn (ug/l)	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0	<60.0
As (ug/l)	<2.0	4.5	2.2	<2.0	<2.0	3.3	<2.0	3.3
Hg (ug/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1242 (ug/l)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	0.8
Aroclor 1248 (ug/l)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	0.5
Aroclor 1254 (ug/l)	<1.0	<1.0	<0.1	<0.1	<1.0	<1.0	0.1	<0.1
Aroclor 1260 (ug/l)	<1.0	<1.0	<0.1	<0.1	<1.0	<1.0	0.1	<0.1
Aldrin (ug/l)	<0.01	<0.5	<0.1	<0.1	<0.01	<0.5	<0.1	<0.1

*Values for NH_3 actually represent concentrations of total ammonia as nitrogen (By telephone, Mr. Wayne Kaiser, USEPA Western District Office, to Ms. Catherine Garra, USEPA Region V, 17 September 1979).

**Not within recommended Federal criteria for pollution control (USEPA 1972, 1976).

0.25 mg/l in samples from the downstream station. The difference between the upstream samples and the downstream samples appears to reflect the loading from the WWTP. Fecal coliform counts for upstream samples ranged from 23 to 490 MPN/100 ml, and those for downstream samples ranged from 23 to 2,400,000 MPN/100 ml. Again, the difference between the upstream and downstream samples reflects the loading from the WWTP. Dissolved oxygen concentrations in the upstream samples ranged from 2.0 mg/l to 4.2 mg/l, and ranged from 1.65 mg/l to 4.15 mg/l in samples from the downstream station. All of the mercury concentrations upstream were less than 0.1 ug/l. Downstream samples contained less than 0.1 ug/l in June and 0.1 ug/l in July, August, and September. Fluoride concentrations ranged from 0.086 mg/l to 0.2 mg/l at the upstream station, and ranged from 0.068 mg/l to 5.2 mg/l at the downstream station. The concentration of 5.2 mg/l in June at the downstream station exceeded the State standard.

A water quality standard exists for un-ionized ammonia (NH_3), but concentrations of un-ionized ammonia in the Fox River were not determined. However, concentrations for total ammonia as nitrogen from the upstream station ranged from 0.04 mg/l to 0.10 mg/l. Values for samples from the downstream station ranged from 0.12 mg/l to 0.48 mg/l. This difference in the values appears to reflect loadings from the WWTP.

PCBs were used by the National Cash Register plant in Portage in the manufacture of carbonless papers prior to 1971. National Cash Register processes its wastewater effluent through the WWTP. Carp downstream from the WWTP have been found to contain PCBs in excess of the tolerance level of 5 ppm established by the US Food and Drug Administration. The PCBs in the wastewater effluent have continued to occur in significant concentrations, although significant decreases have occurred since 1971. The toxicant appears to have remained in the WWTP digester supernatant and in the National Cash Register holding tank. PCB measurements from the National Cash Register plant and the Portage WWTP, and from an industrial-commercial-residential PCB survey are summarized in Appendix D, Tables D-5 to D-7.

USEPA measured PCB concentrations in the Fox River during June, July, August, and September 1978 (USEPA 1979b). The majority of the values measured were less than the level of instrument sensitivity (Table 15). Values within the range of instrument sensitivity ranged from 0.1 ug/l to 0.8 ug/l at the downstream station. These values are very high in comparison with the recommended concentration of 0.001 ug/l (USEPA 1976b). WDNR is continuing to sample PCBs at the WWTP.

As part of the 1978 USEPA water quality study, samples from the WWTP effluent were collected and analyzed (Table 16). The National Pollution Discharge Elimination System (NPDES) permit in effect at the time of the study limited the discharge of the following pollutants:

- BOD_5 (monthly) to an average of 50 mg/l
- BOD_5 (weekly) to an average of 70 mg/l
- Fecal coliform (monthly) to an average of 200 MPN/100 ml
- Total phosphorus (monthly average) to 4 mg/l.

Table 16. Water quality data for the Portage, Wisconsin, wastewater treatment plant effluent (USEPA 1979b).

Parameter	June	July	August	September
NO_3-NO_2 (mg/l)	0.46	2.47	6.27	3.83
NH_3 (mg/l)	10.70	8.32	3.67	3.36
TKN (mg/l)	16.90	17.00	7.18	6.36
Total phosphorus	6.42	10.00	2.66	5.24
BOD_5 (mg/l)	65.50	54.50	37.00	27.00
Fecal coliform (MPN/100 ml)	170.00	63.00	130,000.00	33,000.00
Dissolved oxygen (mg/l)	--	--	--	--
Temperature (°C)	17.00	18.00	21.00	20.00
Fluoride (mg/l)	5.80	0.46	0.53	0.43
Cd (ug/l)	<2.00	17.00	<2.00	<2.0
Cr (ug/l)	20.00	17.00	27.00	19.00
Cu (ug/l)	12.00	26.00	17.00	17.00
Fe (ug/l)	1,240.00	1,780.00	748.00	680.00
Mn (ug/l)	272.00	288.00	106.00	108.00
Ni (ug/l)	<5.00	<5.00	<5.00	<5.00
Pb (ug/l)	<20.00	<20.00	23.00	62.00
Zn (ug/l)	67.00	123.00	72.00	261.00
As (ug/l)	30.00	<2.00	<2.00	8.00
Hg (ug/l)	3.40	4.00	3.60	3.40
Aroclor 1242 (ug/l)	<0.10	13.00	2.30	3.00
Aroclor 1248 (ug/l)	5.00	6.90	1.00	<0.50
Aroclor 1254 (ug/l)	<1.00	<1.00	<0.10	<0.10
Aroclor 1260 (ug/l)	<1.00	<1.00	<0.10	<0.10
Aldrin (ug/l)	<0.01	<0.50	<0.10	<0.10

Both fecal coliform and total phosphorus concentrations were high in the effluent. The PCB concentrations (as Aroclor) also were at a high concentration in June (Aroclor 1248), July (Aroclor 1242, Aroclor 1248), August (Aroclor 1242, Aroclor 1248), and September (Aroclor 1242).

2.6.5.5. Point Sources

Point sources are those pollutants that enter a stream through a discharge pipe or ditch. The Lower Wisconsin River Basin has relatively few point sources compared with the Upper Wisconsin River Basin that has numerous paper mills. It is expected that these paper mills will reduce their pollutant loadings to the River by about 85% from previous years by the installment of new treatment systems. These paper mills collectively released 50,000 lbs per day of BOD_5 into the Wisconsin River during 1977 (Krill 1977).

There are several major and minor tributaries in the Lower Wisconsin River Basin that convey nutrients and pollutants to Lake Wisconsin (Table 17). Approximately 21,000 people are served by municipal sanitary sewage districts that discharge treated sewage effluent to tributaries of the Wisconsin River between Portage and Lake Wisconsin. Numerous industries, including feedlots and dairy processing, canning, meat processing, and light manufacturing facilities, also discharge process waters in the study area. These industries discharge process waters to land application sites that sometimes overflow to surface waters (WDNR 1977c). The estimated total point source loading of phosphorus that is discharged between the Wisconsin Dells and Lodi areas to Lake Wisconsin is approximately 69,300 lbs per year.

The upper part of the Fox River Basin has only one point source. This is the Pardeeville WWTP, which is located approximately 7.0 miles upstream from Portage.

2.6.5.6. Nonpoint Sources

Nonpoint sources are those pollutants that enter a stream by diffuse methods instead of through a discharge pipe or ditch. These pollutants generally are associated with intensive rainfalls, snowmelts, or other runoff events. Because the sources are diffuse, they are difficult to measure or predict.

The nonpoint source problems of the lower part of the Wisconsin River Basin have not been identified specifically. The major nonpoint source of pollution is agricultural land. Urban areas also contribute pollutants via runoff.

WDNR has attempted to estimate the nonpoint pollutant contribution from animal waste through the application of animal units representing approximately 1,000 pounds of animal. It was determined that Pacific Township (the township in which Portage is located) had 21.57 animal units per square mile. WDNR determined that 15 to 30 animal units per square mile were of low priority in dealing with nonpoint source pollution. Caledonia Township (which is located downstream from Portage and includes a section of the Baraboo River Watershed) had 41.26 animal units

Table 17. Receiving streams in the Lower Wisconsin River Basin between Portage and Lake Wisconsin.

Watershed	Town	Contributing Population	Average Daily Flow (mgd)
Wisconsin River	Badger Army Ammunition Works (not on line currently)	NA	8.0
Baraboo River	Kendall	468	0.04
	Elroy	1,513	0.4
	Union Center	205	0.035
	Wonewoc	835	0.125
	Reedsburg	4,585	1.2
	Baraboo	7,931	1.3
	Hillsboro	1,231	0.12
	Loganville	NA	NA
	LaValle	NA	NA
	North Freedom	NA	NA
	Rock Springs	NA	NA
	Sauk County Health Care Center	NA	NA
Duck Creek	Cambria	631	0.58
	Columbia Co. Hospital and Home, Wyocena	500	0.45
Rowan Creek	Poynette	1,118	0.08
Spring Creek	Lodi	1,831	0.285
Rocky Rim Creek	Rio	NA	NA
	Columbia Power Plant	NA	NA

NA - Not available.

per square mile. According to WDNR, between 30 and 60 animal units per square mile represents a potential for serious nonpoint source pollution (WDNR 1976c.)

USEPA estimated that the average annual nonpoint source loading of phosphorus between the Wisconsin Dells and Lodi areas to Lake Wisconsin is approximately 1,160,770 pounds (1974b). Nonpoint sources contribute approximately 96% of the present phosphorus load. Additional non-point source information, presently being developed as part of the 208 planning program, will be presented in the Final EIS.

2.7. Terrestrial and Aquatic Flora

2.7.1. History

Columbia County, Wisconsin is located just south of the zone separating the northern hardwoods region to the northeast from the prairie-forest province to the southwest. Nine plant community types are known to have existed in presettlement times in Columbia County: bur oak savanna, black oak savanna, prairie, xeric sand prairie, upland oak forest, upland black oak forest, marsh, floodplain forest and tamarack swamp. The predominant plant community types were bur oak savanna, prairie, marsh, and upland oak forest, occupying 24.1%, 23.1%, 18.3%, and 13.1% of the County, respectively (Tans 1974). These major plant community types were still abundant in 1882, according to the documentation of the major plant associations occurring in southern Wisconsin by Chamberlin (Braun 1974).

The composition and distribution of these plant communities changed significantly after 1882. As agricultural development expanded, vast areas were cleared of vegetation, local land-clearing fires went out of control, and marshes and swamps were drained (Barrett 1962).

2.7.2. Contemporary Flora

Thirteen land cover types were recognized in the expanded study area, based on field observations on 22 and 23 February 1978 and on 1978 aerial photographs (scale 1:2,000). Each land cover type is discussed briefly in the following paragraphs. The locations of the predominant land cover types, perennial streams, and bodies of water are depicted in Figure 8. Scientific equivalents of the common names of plant species mentioned in this section are listed in Appendix E, Table E-1.

2.7.2.1. Agricultural Land

Approximately 15,390 acres in Fort Winnebago Township, Lewiston Township, and Pacific Township were cultivated in 1978. The principal crops grown in this area were corn and alfalfa, which accounted for 44% and 23% of the agricultural land, respectively. Oats, hay, mint, soybeans, onions, carrots, and potatoes also were cultivated in these three townships. Mint, carrots, onions, and potatoes were grown in drained marshes on muck-type soil. Corn, alfalfa, hay, and oats were cultivated on better drained, sandy loam soils (By telephone, Mr. Ray Johnson, Portage County Extension Agency, to Ms. Anita Locke, WAPORA, Inc., 8 March 1978).

2.7.2.2. Barren Land

Areas with little or no stable vegetation are classified as barren. Gravel pits and landfills are examples of areas included in this classification.

2.7.2.3. Floodplain Forest

Floodplain is a general term used to describe lowlands bordering watercourses that retain large volumes of water during periods of flooding. The vertical and horizontal distribution of plant communities on the floodplain is determined largely by the meandering course of the river. As the river flows, alluvium (unconsolidated material) is deposited on the inside of the curved banks, and soil and vegetation are eroded from the outside curve. The fully-exposed, fresh, alluvial soil is prime habitat for pioneering tree species such as willow, cottonwood, river birch, and silver maple.

Different forest types generally develop along a gradient from the river edge. The youngest pioneer stands develop along the edge of the river (silver maple, birch, cottonwood, willow); cottonwood, ash, silver maple, and American elm develop as a transitional type near the edge; and boxelder, ash, American elm, and oak develop as a terminal forest type away from the river. The proportion of the floodplain area occupied by pioneer, transitional, and terminal forest types is determined by the rate of meandering (Johnson and others 1976).

Rapid meandering results in an accelerated erosional-depositional pattern. This favors black willow and cottonwood and maintains a relatively low mean age. Conversely, a slower rate of meandering, or the absence of spring floods for several consecutive years, favors the establishment of transitional forest associations. The absence of pioneer species is indicative of an older, terminal forest.

The trees along the Wisconsin River range from approximately 70 to 100 feet in height and from 18 to 58.5 inches in diameter at breast height (dbh). The canopy layer along the outer curves of the River is characterized predominantly by silver maple, intermixed with cottonwoods. As the River meanders inward, river birch becomes prevalent along the borders, accounting for over 75% of the cover. Green ash, white ash, black ash, and American elm increase in distribution and abundance in both the shrub and canopy layers as one moves away from the River. Pin oak occurs along the periphery of the transitional forest type. Other species present include hackberry, pecan, and black cherry. The shrub layer is intermittent, with dense patches of prickly ash, wild black currant, white mulberry, and common elder.

The Fox River does not meander as frequently or as rapidly as the Wisconsin River. As a result, the floodplain forest is not as extensive along the Fox River as it is along the Wisconsin River.

Floodplain vegetation provides food and cover for a variety of animals. Most of the animals that reside in these habitats on a permanent basis, such as worms, snails, waterfowl, and some songbirds,

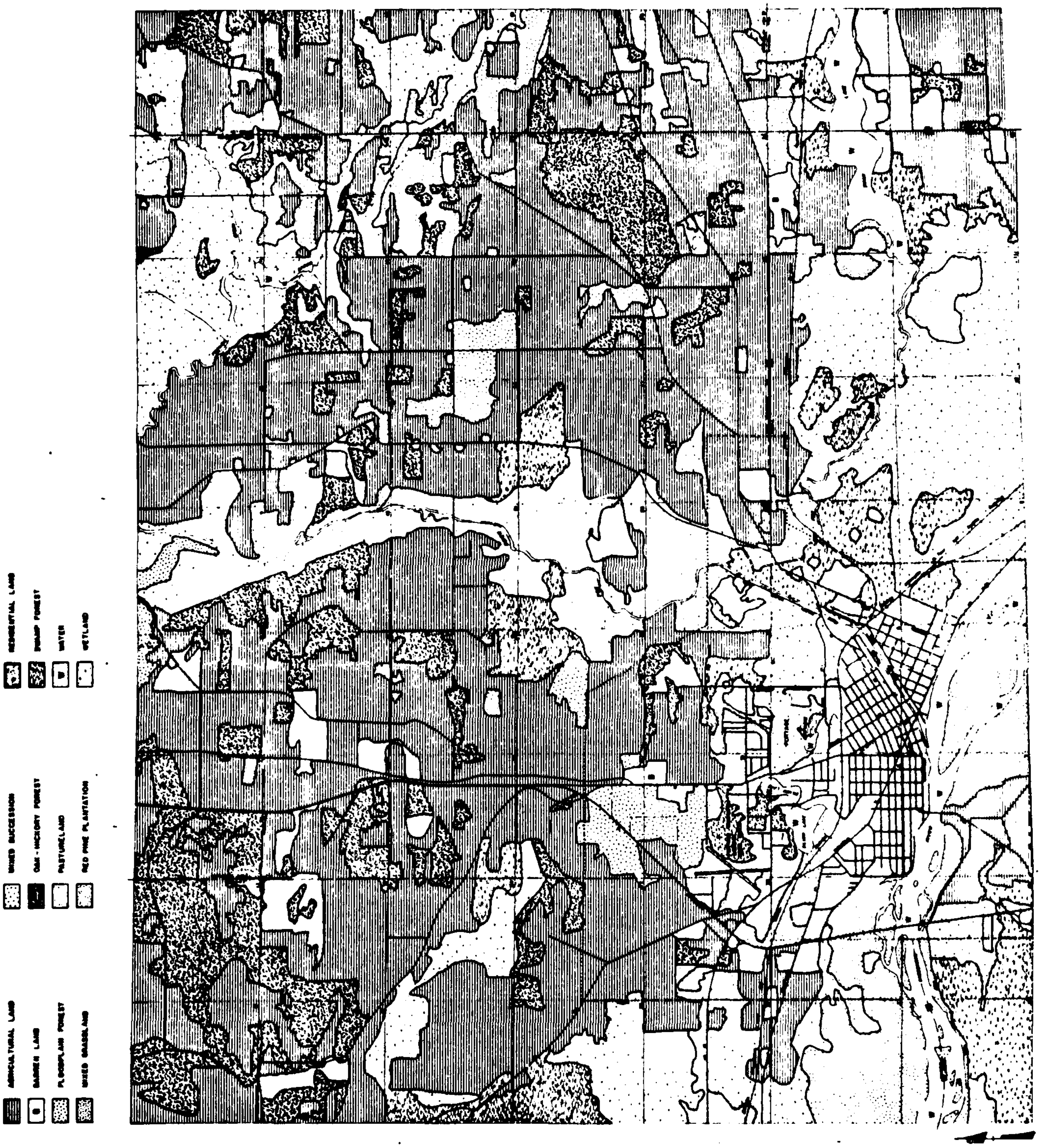


FIGURE 8 LAND COVER

require moist habitats and can tolerate or escape periodic flooding. Other animals, including rabbits, voles, foxes, raccoons, deer, and many birds, utilize floodplains on a regular basis.

2.7.2.4. Hedgerows

Hedgerows border some of the agricultural fields in the expanded study area. Species of shrubs and trees commonly found in hedgerows include Lombardy poplar, black cherry, hawthorn, and elderberry. Hedgerows were not indicated on the land cover map because of their small size.

2.7.2.5. Hemlock-White Pine-Northern Hardwood Forest

The Silver Lake Cemetery, located on a ridge approximately 840 feet msl, has an array of trees typical of the hemlock-white pine-northern hardwoods group. Eastern hemlock, northern white cedar, white pine, and red pine are common and range from approximately 80 to 100 feet in height. Mature blue spruce, Norway spruce, common juniper, Norway maple, bur oak, silver maple, basswood, slippery elm, paper birch, and pin oak also are present. The grounds are maintained by periodic mowing, limiting the herbaceous layer to grasses. Shrubs that are not abundant are primarily ornamental.

2.7.2.6. Mixed Grasslands

Open fields dominated by a mixture of native and/or alien grasses are classified as mixed grasslands. Golf courses are included in this category.

2.7.2.7. Mixed Succession

Lowland and upland sites, which are covered with native and alien shrubs mixed with grasses and forbs, are designated as mixed succession. Fescue, foxtail grass, aster, hardhack, horsemint, meadowsweet, swamp milkweed, and bouncing bet are the most common forbs and grasses. Hawthorn, viburnum, dogwood, black cherry, and elderberry are the most frequently observed species of shrubs.

2.7.2.8. Oak-Hickory Forest

This forest type occurs on slopes throughout the study area and is dominated by white oak and black oak. Associated with this forest type are northern red oak, pin oak, bitternut hickory, and black cherry. The shrub layer is sporadically abundant, consisting primarily of black cherry, bitternut hickory, and white oak sprouts.

Fifty-eight percent of the black cherry growing in upland forests in southern Wisconsin became established during the drought years of the 1930s, when many woodlots were being used for grazing (Peet and Loucks 1977). During the drought, canopy development was diminished and more light penetration was allowed. The increase of light favored the growth and development of both black cherry and hickory.

2.7.2.9. Pastureland

Fields used for grazing animals were categorized as pastureland.

2.7.2.10. Red Pine Plantation

Small, even-aged stands of red pine occur throughout the expanded study area. The heights of the stands range from 20 feet to 30 feet. Plant associations vary in the different stands and include pure red pine, red pine and black locust, and mixed white pine, red oak, pin oak, black oak, black cherry, and black locust. If hardwoods are present, they generally occur along the periphery of the stand or in openings within the stand. The shrub layer is sporadic and rarely dense. Pure red pine stands occur on sandy soils with a humus layer. Mixed pine-hardwood stands are indicative of soils in which the humus layer has been incorporated into the sand.

2.7.2.11. Residential Land

Residential land includes the City of Portage, farmhouses and lawns, schools, and industrial areas. Large native and introduced species of trees occur throughout the residential land. Catalapa, silver maple, weeping willow, American elm, slippery elm, Norway spruce, red pine, white pine, and common juniper are among the most prevalent species of trees.

2.7.2.12. Swamp Forest

Forested areas that are located within wetland areas, or on the periphery of wetland areas, and that are growing on lowland, mesic soils are designated as swamp forest. The species of trees associated with swamp forest are quaking aspen, black willow, balsam poplar, basswood, boxelder, and birch. The shrub layer is dense, particularly at the periphery. Species of shrubs include red-osier dogwood, willow, privet, and viburnum.

2.7.2.13. Wetlands

Wetlands can be defined in general terms as poorly-drained areas where "water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface" (Cowardin and others 1977). The diversity of wetland types, the continuous gradation between dry and wet environments, and the seasonal and yearly variations that occur in wetland areas make it difficult to delineate the various wetland ecosystems for the purposes of inventory, evaluation, and management. For this inventory, areas covered with marsh and swamp vegetation types are classified as wetlands.

Marsh is a general term used to designate areas without woody vegetation where the soil lies above the water table for most of the year. The vegetation is dominated by grasses, reeds, rushes, sedges, and other soft-stemmed herbaceous plants. Many of the plants grow in clumps and have heavy, fibrous root systems that can anchor into mucky soils.

In general, a marsh originates as the result of natural filling in of shallow lakes or depressions. As time passes, there is a tendency for organic matter to accumulate and for drainage to improve. Seeds of woody shrubs may be established at this stage, and the marsh slowly is succeeded by swamp.

Cattail marshes grow intermittently around the peripheries of both Mud Lake and Silver Lake. These marshes overlap into shrub swamps that are dominated by red-osier dogwood, Japanese knotweed, swamp privet, various species of willow, hawthorns, wild cucumber, hardhack, mothers-wort, thistle, and meadowsweet. The shrub swamps overlap into swamp communities that are dominated by trees such as cottonwood, boxelder, balsam poplar, basswood, American elm, and pin oak. Cottonwood and boxelder are the predominant species in both the canopy and shrub layers. Other marsh and swamp areas around Portage have similar community types.

Both marsh and swamp plant communities support a diverse and abundant wildlife. A variety of lower invertebrates, snails, insects, frogs, and birds thrive in these habitats. Mammals dwelling in marshes and swamps include the shorttail shrew, redback vole, muskrat, and harvest mouse (Ives and others 1973; Smith 1974).

2.7.2.13.1. Regulations Concerning Wetlands

Species of plants common to wetland areas, such as largetoothed aspen, cottonwood, willow, alder, cattail, bulrush, and other aquatic plants, historically have been regarded as having little economic value. Consequently, wetlands generally have been regarded as wastelands. In the past, legislation was created to help farmers and developers "renovate" wetlands to "more useful" land. The Swamp Land Grants Act of 1850, issued by the Federal Government, is an example of legislation that was designed to encourage the conversion of wetlands to other land uses that have higher economic value. Later, the Federal Swamp Lands Act authorized the draining and filling of wetlands (Holcomb Research Institute 1977).

States in the midwest, in particular, were affected by this Act. During the 1920s and 1930s, marsh and bog acreage was reduced to 10% of the original total in Missouri, Michigan, Illinois, Indiana, and Ohio. The reduction of wetland acreage in Wisconsin, while significant, was not as dramatic. By 1960, approximately half of the known original 5 million acres of wetlands in Wisconsin had been drained (Wisconsin Conservation Department 1960).

Historically, the majority of the wetland acreage that was drained and filled was developed for agricultural use. A 1938 survey of the wetlands in Columbia County showed that approximately 28% of the remaining wetlands were being pastured (Wisconsin Conservation Department 1960). Because grazing mammals have palatability preferences, grazing results in the selective removal of plant species. In areas where overgrazing occurred, there was an ingress of toxic, spiny and/or woody species not previously present (Harper 1969). In recent years, urbanization also has accounted for the loss of much of the wetland acreage.

Public recognition of the natural resource values of wetland areas is slowly bringing about a shift in wetland policies from draining and filling to conservation. The State of Wisconsin Natural Resources Board has approved and adopted rules that pertain to the preservation, restoration, and management of wetland areas (State of Wisconsin Natural Resources Board 1977). In addition, the Federal Government "... requires Federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this Executive Order" (Executive Order 11990, 1979). Nevertheless, the legal recourse available for wetland preservation still is limited primarily to indirect approaches (Bedford and others 1974; by telephone, Mr. Floyd Stautz, WDNR, to Ms. Anita Locke, WAPORA, Inc., 7 February 1978).

2.7.3. Endangered or Threatened Species of Plants

A list of the species of plants that may be present within the expanded study area and that have been included in the WDNR list of endangered and threatened species (WDNR 1979b) is contained in Appendix E, Table E-2. It should be noted that while the ranges of these species may encompass the expanded study area, no collections or sightings of these species are known to have been made in the Portage area. No species of plants recorded as extant within the study area are included in the Federal endangered and threatened species list (59 CFR 17). Each species has been listed according to the habitat in which it most commonly occurs.

2.8. Terrestrial and Aquatic Fauna

Documented information on wildlife that pertain specifically to the study area was not found during a literature search. However, pre- and post-operational environmental surveys were conducted (1971-1977) for the Columbia Generating Station (CGS), which is located approximately 4 miles southeast of the study area. Similar habitat types exist in the study area and in the nearby CGS land, and thus, wildlife types should be similar in both areas.

Results of pre-operational surveys conducted by WDNR, Industrial Bio-Test Laboratories, Inc., Dames and Moore, Deerwester, and the University of Wisconsin in 1971 are summarized in the Final Environmental Impact Statement for the Columbia Generating Station (US Army Corps of Engineers [COE] 1974). Results from continuing investigations by the University of Wisconsin during the period from 1972 to 1977 also are available, as are results from an impingement/entrainment survey conducted by Swanson Environmental. These programs provide information on the presence or absence of wildlife in the area, but provide little information on population densities.

Because scientific data pertaining to the Fox River in the Portage vicinity were virtually nonexistent, a short-term survey was conducted by USEPA on the Fox River near Portage during Summer 1978. The Wisconsin River also was included in the survey to supplement existing data for that River. Three stations were sampled on each river during June, July,

and August. Stations on the Fox River were located in the immediate area of the existing WWTP, and upstream and downstream from the WWTP; and stations on the Wisconsin River were located near the proposed WWTP site, and upstream and downstream from the proposed site (Figure 9). Substations were located approximately 50 yards from each shore and at the midpoint of transects crossing the Wisconsin River at each station. The survey involved sampling of chlorophyll *a*, periphyton, phytoplankton, zooplankton, macroinvertebrates, and fish. Physical and chemical parameters, including dissolved oxygen, pH, temperature, and specific conductance, also were measured.

2.8.1. Amphibians and Reptiles

Thirty-four amphibian and reptile species were observed on or near CGS property (US Army COE 1974; University of Wisconsin 1976c). The species observed are listed in Appendix F, Table F-1. The timber rattlesnake (*Crotalus horridus horridus*) is included in this list. On one occasion, investigators observed several snakes believed to be timber rattlesnakes, but positive identification was not made (see Appendix G).

Two sightings of the eastern massasauga (*Sistrurus catenatus*), which is listed as endangered by the State of Wisconsin (WDNR 1979a), were noted. Species observed that are listed as threatened by the State of Wisconsin included the spotted salamander (*Ambystoma maculatum*), Blanding's turtle (*Emydoidea blandingi*), and the western glass lizard (*Ophisaurus attenuatus*). No amphibians or reptiles observed are included in the Federal list of endangered and threatened species (59 CFR 17).

2.8.2. Birds

The many lowlands in the Portage study area provide ideal habitats for a great number of species, and supply a variety of food and shelter types for both resident and transient birds. As a result, waterfowl and other water-associated birds such as herons, bitterns, woodcock, and sandpipers are common. The University of Wisconsin has documented the presence of more than 190 species of birds on the CGS property (Appendix F, Table F-2).

Species of waterfowl that regularly nest in the area include wood ducks (*Aix sponsa*), mallards (*Anas platyrhynchos*), blue-winged teal (*Anas discors*) and coot (*Fulica americana*). Migrant ducks are plentiful during the autumn and the spring. Large numbers of pintails (*Anas acuta*), gadwalls (*Anas strepera*), green-winged teal (*Anas carolinensis*), shovelers (*Spatula clypeata*), and others utilize the area for resting and feeding purposes (By interview, Mr. Pat Kaiser, WDNR, with M. Dick McKean, WAPORA, Inc., 23 February 1978).

Floodplain forests along the Fox River and the Wisconsin River provide relatively undisturbed areas for shelter and nesting for hawks, eagles, herons, and other birds easily disturbed by human encroachment. One such floodplain forest that is located near the CGS plant has been successfully utilized in recent years as a rookery for the great blue heron (*Ardea herodias*). The number of birds in the rookery, however, appears to be declining (University of Wisconsin 1976a).

The double-crested cormorant (*Phalacrocorax auritus*), the bald eagle (*Haliaeetus leucocephalus*), and the osprey (*Pandion haliaetus*) have been observed in the CGS area and are listed as endangered by the State of Wisconsin (WDNR 1979b). The great egret (*Casmerodius albus*), the red-shoulder hawk (*Buteo lineatus*), Cooper's hawk (*Accipiter cooperi*) and the loggerhead shrike (*Lanius ludovicianus*) are listed as threatened. No species observed are listed in the Federal list of endangered and threatened species.

2.8.3. Mammals

At least 41 species of mammals have been observed in the Portage area since 1971 (Appendix F, Table F-3). Lowlands and wetlands in the area provide suitable habitats for many species of mammals. Eastern cottontail (*Sylvilagus floridanus*), mink and weasels (*Mustela* spp.), foxes (*Urocyon* spp.), whitetail deer (*Odocoileus virginianus*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicus*) may be present in these habitats. Mammals that receive the greatest hunting and trapping pressure include deer, rabbit, raccoon (*Procyon lotor*), muskrat, fox, beaver, and mink (University of Wisconsin 1976a, 1976b; US Army COE 1974).

Information is not available on population densities of mammals in the Portage study area. However, WDNR believes that populations are stable because no species of mammals known to be present in this area are considered to be endangered or threatened by Federal or State authorities.

2.8.4. Water Quality For Fauna

Dissolved oxygen, temperature, pH, and specific conductance were monitored during the USEPA survey (1978a). Dissolved oxygen concentrations in the Fox River ranged from 2.2 to 14.4 mg/l, while concentrations in the Wisconsin River ranged from 6.6 to 9.6 mg/l. Concentrations at Stations 2 and 3 on the Fox River were considerably lower than concentrations at Station 1. Water temperatures ranged from 16.0 to 23.5°C in the Fox River and from 17.0 to 26.3°C in the Wisconsin River. The pH values for both rivers were between 7.0 and 8.5. Specific conductance was greater on the Fox River, where it ranged from 360 to 560 micromhos per centimeter (umhos/cm), than on the Wisconsin River, where the values ranged from 140 to 160 umhos/cm.

2.8.5. Chlorophyll

USEPA sampled for chlorophyll *a* from two stations on each river (1978a). Chlorophyll *a* concentrations ranged from 5.19 ug/l to 65.9 ug/l on the Fox River and from 9.85 to 28.95 ug/l on the Wisconsin River (Appendix F, Table F-4). Average chlorophyll *a* concentrations for the stations on each river were similar: 18.9 ug/l for the Fox River and 18.3 ug/l for the Wisconsin River. Average monthly concentrations for both rivers were lowest in July (11.29 ug/l for the Fox River and 11.85 ug/l for the Wisconsin River). The highest monthly average for the Fox River was for June (28.35 ug/l), and the highest average for the Wisconsin River was for August (24.83 ug/l).

2.8.6. Periphyton

Periphyton samples were collected from the Wisconsin River and the Fox River during the USEPA survey (1978a). Twenty species of algae were found on the periphytometers in the Wisconsin River. A species of Oscillatoria (a blue-green alga) was the predominant organism. It was present at Stations 2 and 3 in numbers up to 4,300 cells per square millimeter (cells/mm^2). Other algae present in densities greater than 1,000 cells/mm^2 at one or more stations included Aphanizomenon flos-aquae (a blue-green alga) and Cocconeis sp. (a pennate diatom). Station 1 had fewer species and fewer individuals than did Stations 2 and 3. Stations 3a and 3c varied considerably in cell composition and in cell number.

Eighteen species of algae were collected from the Fox River. A species of Cocconeis was the most abundant organism and was found at densities up to 13,594 cells/mm^2. Two species of blue-green algae, Oscillatoria sp. and Coelosphaerium kutzingianum, also were common and were found at densities as high as 5,950 cells/mm^2 and 2,800 cells/ mm^2, respectively. The number of species present at Station 2 was slightly greater than that at Station 1, but a higher number of cells was recorded at Station 1. Data were not collected at Station 3. The number of organisms per milliliter of each species collected from the Fox River and the Wisconsin River is given in Appendix F, Table F-5.

2.8.7. Phytoplankton

Phytoplankton were collected from each river during the USEPA survey (USEPA 1978a). Between 55 and 60 species ~~of~~ algae were present ~~in~~ each river during the summer sampling period. Blue-green algae (Anabaena sp. and Aphanizomenon flos-aquae) were the most abundant algae in the June samples for the Fox River. As the summer progressed they decreased in number, and flagellates (Cryptomonas sp. and others) increased in number. By August the flagellates were the predominant species present. Phytoplankton densities were greatest at Station 1 throughout the summer. The number of cells per milliliter (cells/ml) ranged from 2,729 to 14,910. The average number of cells/ml for all sample dates was 7,771.

Centric diatoms (predominantly Melosira sp.) and flagellates (predominantly species of Cryptomonas) were the most abundant phytoplankton present in the Wisconsin River. Average densities for these two groups across all samples were 2,438 cells/ml and 2,660 cells/ml, respectively. Flagellate populations increased substantially from June to August. Blue-green algae (predominantly species of Anacystis) and green algae (Ankistrodesmus falcatus, species of Crucigenia and Scenedesmus, Schroederia sitigera, and others) also were abundant. The average concentration for the blue-green algae was 1,265 cells/ml. For the green algae it was 970 cells/ml. Station 3 supported the greatest density of phytoplankton (an average of 10,278 cells/ml for the 3-month sampling period). Densities ranged from 3,830 cells/ml (at Station 2c during July) to 11,840 cells/ml (at Station 3 during August). The average phytoplankton density for the Wisconsin River stations during the summer was 7,714 cells/ml. The major phytoplankton groups collected from the Wisconsin River and the Fox River during the summer of 1978 are shown in Appendix F, Table F-6, and the species collected during the survey are listed in Appendix F, Table F-7.

Microcystis aeruginosa (a blue-green alga) was observed during all sample periods on the Wisconsin River and was reported to have reached "bloom" conditions in August. However, this species was not indicated as present in the Wisconsin River in the phytoplankton tables contained in the USEPA report (1978a).

2.8.8. Zooplankton

A zooplankton survey was conducted during 1973 on the Wisconsin River near the CGS plant. Two tributaries that empty into the River near the plant, Rocky Run Creek and Duck Creek, also were surveyed. The study was designed to determine the population densities and relative diversity of zooplankton in the River, and was directed by the University of Wisconsin. Seven stations were sampled bimonthly from June through October 1973. Stations 1 and 2 were located on Duck Creek, Stations 3, 4, and 5 on the Wisconsin River, and Stations 6 and 7 on Rocky Run Creek (Appendix F, Figure F-1).

Over 55 species were collected (Appendix F, Tables F-8 and F-9). Zooplankton concentrations (based on one to three samples) ranged from 0 to 7,028/m^3. Results from the Wisconsin River stations indicated high diversity, with population densities peaking in late September. Other peaks were noted in late October and August. Densities often were lower in the River than in the two creeks. Densities also were considered to be low compared to other rivers. This may be due to the swift current of the Wisconsin River.

Zooplankton samples also were collected by USEPA from the Fox River and the Wisconsin River (1978a). Rotifers (predominantly *Keratella cochlearis* and *Synchaeta* sp.) were the zooplankton most commonly collected from the Wisconsin River. Station 1 supported a higher average density of zooplankton than did Station 3 (77 organisms per liter [organisms/l] to 52 organisms/l). Densities decreased during the summer, largely due to declining rotifer populations. The greatest density at any station was 139 organisms/l (at Station 1 during June) while the lowest density was 24 organisms/l (at Station 3 during August). Twenty-five species of zooplankton were collected. Two species, *Eubosmina coregoni* and *Brachianus angularis*, had not previously been collected in the study area.

Samples from the Fox River also were composed primarily of rotifers. *Keratella cochlearis* was the most abundant species. Rotifer populations at Station 1 were relatively small in June (5 organisms/l), but increased to 153 organisms/l in July and 166 organisms/l in August. Populations at Station 3 remained relatively small throughout the summer, and reached a maximum of 25 organisms/l in July. Twenty-four species of zooplankton were collected from the Fox River. Cladoceran and copepod populations were low at both stations throughout the summer. The greatest number of copepods collected at any station during the survey was 3 organisms/l, and the greatest number of cladocerans collected was 22 organisms/l. The major zooplankton groups present in both rivers are listed in Appendix F, Table F-10, and the species within each group are given in Appendix F, Table F-11.

2.8.9. Macroinvertebrates

The University of Wisconsin conducted macroinvertebrate investigations on the Wisconsin River, Duck Creek, and Rocky Run Creek at CGS from 1973 thru 1977. The sampling stations were the same as those used for the zooplankton studies (2.8.8.). Three additional stations were added to Rocky Run Creek in 1974. Macroinvertebrate data for the Upper Fox River were not found in the literature.

Over 100 species were present in the creeks, and over 68 species were collected from the Wisconsin River (Appendix F, Table F-12). In 1973 and 1974, the greatest numbers of species and individuals were collected during early summer (May and June), while the lowest numbers of individ uals were collected during September and October. Caddisflies (*Cheumatopsyche* sp. and *Hydropsyche* sp.) and mayflies (*Baetis* sp., *Caenis* sp., *Isonychia* sp., and various members of the family Heptageniidae) were the most abundant organisms found on the artificial substrate samplers. Little variation was evident between upstream and downstream stations, and percent composition at each station was similar (Appendix F, Figure F-2). Macroinvertebrates common to all locations were *Hyallela azteca* (amphipod), *Asellus recovitzai* (an isopod), and a member of the family Corixidae (true bugs). *Stenonema terminatum* and *Heptagenia flavescens* (both mayflies) and *Isoperla* sp. (a stonefly) were found only in the Wisconsin River. A species of *Callibaetis* (a mayfly) and *Gammarus pseudolimnaeus* (an amphipod) were collected from the creeks, but not from the River. A member of the family Corixidae and a species of *Leptocella* (a caddisfly) were the organisms considered best suited to adjust to the shifting substrates of the Wisconsin River. Species of *Cheumatopsyche*, *Hydropsyche*, and *Stenonema* were temporary residents that depended upon the availability of appropriate habitat.

Macroinvertebrates also were sampled from the Wisconsin River by USEPA (1978a). Organisms collected in this survey, but not collected in earlier surveys, are listed in Appendix F, Table F-13. Low diversity and low numbers of individuals were reported. A decrease in the number of species present was observed in August. Pollution-tolerant, facultative, and pollution-intolerant organisms were reported to be present at all stations during June, July, and August.

The species of macroinvertebrates collected from the Fox River during the USEPA survey are listed in Appendix F, Table F-14. The diversity of macroinvertebrates was reported to be higher in the Fox River than in the Wisconsin River, but this diversity decreased during the summer. Qualitative samples from Station 1 were an exception. The number of species at Station 1 increased from 24 in June to 37 in August. Station 3 had the most diverse community of the three stations (45 species). Organisms listed in the report as pollution-tolerant increased in abundance during July and August at Stations 2 and 3. A combination of pollution-tolerant, facultative, and pollution-intolerant organisms were present at Station 1 throughout the summer.

2.8.10. Fish

Several fish surveys have been conducted by WDNR, Industrial Bio-Test Laboratories, Inc., and the University of Wisconsin at the CGS site

since 1971. Investigators concentrated their efforts on Duck Creek and Rocky Run Creek, but were able to document the presence of many species of fish during a limited survey of the Wisconsin River. Additional species have been documented through electrofishing by WDNR at Lake Wisconsin, entrainment and impingement studies at CGS by Swanson Environmental, and catches by sport and commercial fishermen in the Wisconsin River and in Lake Wisconsin.

The Wisconsin River System, with its tributaries, backwaters, floodplains, pools, riffles, and Lake Wisconsin, provides the food, shelter, and spawning requirements necessary to support a diverse fishery. Over 40 species have been collected from the Wisconsin River (near Portage) and from Lake Wisconsin (Appendix F, Table F-15). Other species, especially members of the minnow family, may be present. Intensive fishery investigations have not been conducted on the Wisconsin River in the Portage area.

Lake Wisconsin and the Wisconsin River offer excellent sportfishing. Game fish most often sought include walleye (Stizostedion vitreum vitreum), lake sturgeon (Acipenser fulvescens), northern pike (Esox lucius), sauger (Stizostedion canadense), white bass (Morone chrysops), crappies (Pomoxis sp.), bluegills (Lepomis sp.), and yellow perch (Perca flavescens) (By interview, Mr. Tim Larson, WDNR, to Mr. Dick McKean, WAPORA, Inc., February 1978; By telephone, Mr. G. Emerson, WDNR, to Mr. Dick McKean, WAPORA, Inc., 6 March 1978).

WDNR has issued a limited number of commercial fishing permits for Lake Wisconsin since 1974. Commercial fishing is allowed for "rough fish" only. Species such as carp (Cyprinus carpio), buffalo (Ictiobus sp.), and freshwater drum (Aplodinotus grunniens) comprise a large percentage of the marketable catch. To date, over 1.5 million pounds of fish have been marketed (By telephone, Mr. G. Emerson, WDNR, to Mr. Dick McKean, WAPORA, Inc., 6 March 1978).

Very little fisheries information is available for the Upper Fox River. The River and many of its connecting waters were chemically treated with antimycin and rotenone in 1970 to eradicate carp populations (Hacker 1971). In 1971, northern pike, bluegills, perch, sunfish (Lepomis sp.), walleye, smallmouth bass (Micropterus dolomieui), fathead minnow (Pimephales promelas), and channel catfish (Ictalurus punctatus) were stocked in the River (WDNR 1971). Other fish likely to occur are carp, suckers, bullheads, bass, and various species of minnows.

Fish in the Wisconsin River and Fox River also were sampled by USEPA (1978a). Five species of fish collected from the Wisconsin River were identified. The silver redhorse (Moxostoma anisurum) was not listed in earlier literature as a known inhabitant of the River. Five species also were collected from the Fox River (Appendix F, Table F-16). The redear sunfish (Lepomis microlophus) was the most frequent species collected.

No species of fish listed as endangered by the State of Wisconsin (WDNR 1979b) are known to be present in the study area. The river redhorse (Moxostoma carinatum), a species listed as threatened, has been collected from the Wisconsin River.

FEASIBILITY STUDY FOR FLOOD CONTROL

WISCONSIN RIVER

at

PORTAGE, WISCONSIN

APPENDIX H

RECREATION AND LANDSCAPE BEAUTIFICATION

December 1983

APPENDIX H

RECREATION AND LANDSCAPE BEAUTIFICATION

TABLE OF CONTENTS

FIGURES

PLATES

RECREATION AND LANDSCAPE BEAUTIFICATION

INTRODUCTION

This appendix evaluates the proposed flood control alternatives for Portage, Wisconsin, in terms of (a) their impacts on existing recreation facilities and uses; and (b) their potential to provide/accommodate recreation opportunities. General information is presented on recreation facilities and opportunities in and around the city of Portage and the project area.(1) The recreation needs of the region, the county, and the city are also discussed.

A brief review is given for alternatives evaluated in the Stage 2, Alternatives Report for Portage, Wisconsin, January 1981. The alternatives carried forward into this stage (Stage 3) are described and evaluated in greater detail. A conceptual recreation plan is presented for the recommended flood control alternative. The last portion of the appendix discusses landscape beautification measures that could be used with this project.

RECREATIONAL SETTINGS

REGIONAL

In the State Comprehensive Outdoor Recreation Plan (SCORP), Wisconsin is divided into 15 recreation planning regions. Because Portage is located in the northwest corner of region 2, it is necessary to consider the adjoining regions 3, 5, and 6 when assessing the recreation resources of the Portage area. The following paragraphs describe the recreation demands and needs in these regions as contained in the 1977 Wisconsin SCORP.

---

(1) A more detailed report, <u>Draft Recreational Needs Analysis for Portage, Wisconsin</u>, was prepared in January 1980. The report was used extensively in preparation of this appendix. Copies of the report are available for review at the St. Paul District office, Corps of Engineers, Economic-Social-Recreation Branch.

Opportunities for swimming, fishing, boating, and sightseeing on lakes and streams constitute Wisconsin's principal recreation demand; therefore, the State's primary recreational concern is the protection and enhancement of its existing water resources. Because it is unlikely that Wisconsin's water surface area will be increased significantly to meet fishing and boating needs, the focus of improvements must be the access to and quality of the existing waters.

In the lakes of regions 2 and 3, boat densities are almost 2 to 4 times greater than those in northern Wisconsin. Access development needs to be balanced throughout the State to relieve the pressure where densities are high. Some accesses in regions 2 and 3 may be developed as "carry-in" sites to prevent use by larger boats in an effort to help preserve a quality experience.

Canoeing opportunities in regions 2, 3, and 5, which are the most accessible areas to Milwaukee, Chicago and other large population centers, need to be developed to relieve the heavy demand on Wisconsin's Wild and Scenic Rivers. These rivers are used so heavily at population centers that the reasonable carrying capacity may soon be exceeded.

Wisconsin critically needs corridor lands to provide more opportunities for Nordic skiing, bicycling, hiking, horseback riding, snowmobiling, and other off-road vehicle use. These activities represent the State's most rapidly increasing demand for recreation. Most trail-oriented deficiencies are not the result of conflicting uses. Additional trails, longer trails, and more widely distributed trails are needed. Stream corridors, such as those in regions 2, 3, 5, and 6, provide excellent opportunities for canoeing and trail development.

Regions 2, 3, and 6 experience a high demand for picnicking. As suitable picnic areas are developed, the need for picnic areas will increase, especially in region 2 where the need is already great.

Region 2 also experiences above-average demand for swimming. Although the present facilities are apparently sufficient, regions 2 and 5 anticipate growing needs over the next 20 years. These needs may be satisfied by beach or pool facilities.

The demand for developed (modern) camping sites is high in regions 2 and 3 because they are accessible from major population centers within region 2 and the eastern portions of Wisconsin and Illinois. The demand is also high for undeveloped (primitive) camping areas primarily along the Wisconsin River in regions 2 and 5.

The demand for hunting opportunities within the State is relatively stable, increasing only as the general population does. The State's hunting areas are reasonably adequate, but the needs of the game are becoming significant. Therefore, preservation of game habitat is more important than hunting space. The planning of water resources projects can help fulfill these needs, especially for wetland preservation and waterfowl habitat.

COLUMBIA COUNTY

Portage is located in Columbia County in south central Wisconsin. Three major recreation and tourism areas are located wholly or partially within Columbia County. The Wisconsin Dells, a very popular tourist attraction, is approximately 17 miles northwest of Portage. Lake Wisconsin, 12 miles downstream from Portage, provides many recreation opportunities. Devils Lake State Park and several ski resorts are located west of the city along the Baraboo Range. The Range also has many State scientific areas.

Tourism and recreation are an important part of the economy in Columbia County. This is because of the three major tourist areas and the county's location, astride the major transportation routes between the population centers to the southeast and and the northern vacation areas of the State.

Recreation and tourism sales account for approximately 10 percent of the total business activity of the State. Columbia County ranks 23rd of the 72 counties, with sales of $53.6 million (1976 data).

Areas in the county available for recreation include nine wildlife management areas and two fish management areas (trout stream areas) administered by the State. The county administers seven county parks totaling approximately 100 acres. In 1975 there were 36 miles of designated bicycle trails and 54 miles of designated snowmobile trails.

The Columbia County Outdoor Recreation Plan, prepared in 1975, described a need for an additional 150 acres of developed county park areas; more opportunities for camping, swimming, fishing, and boating; and additional trails.

CITY OF PORTAGE

The city of Portage lies between the Wisconsin and Fox Rivers. The Wisconsin River is a tributary of the Mississippi River while the Fox River is in the Great Lakes drainage. The rivers are 1.4 miles apart at this point. Because the rivers were the early transportation routes, this location was an important link between two major transportation networks. The United States built Fort Winnebago in 1828 to protect this link. Fort Winnebago marked the beginning of the city of Portage. For centuries, goods and boats were portaged between the rivers on what was known as the Wauona Trail. In 1876, the Corps of Engineers completed a canal which eliminated the need to portage. The canal was closed in 1951.

The city has been active in providing for the recreation needs of its residents. Currently, the city has approximately 175 acres in 17 areas. The city has six parks on or near the Wisconsin River but no recreation areas on the Fox River. In fact, there is little public recreation development along the Fox River in the vicinity of Portage.

In general, the recreation demands and needs of Portage residents are the same as those outlined for Columbia County and for region 2. The approved development plan for the city projects that an additional 45 acres of park lands will be needed by 1990, increasing to 100 acres by the year 2030.

FLOOD CONTROL ALTERNATIVES

During the study, flood control alternatives were developed and evaluated from the standpoints of engineering and economics, and for their environmental, social, cultural, and recreation effects. The major categories of alternatives considered were levees, channel modifications, diversion channels, changes in upstream reservoirs, and nonstructural. Of those alternatives, only the levee alternative was refined and evaluated in further detail.

AFFECTED RECREATION RESOURCES

The city has six parks located on or adjacent to the Wisconsin River that could be affected by levee development (see plate 1). No recreation areas administered by Columbia County or by the State of Wisconsin would be affected by the proposed alternatives.

The most significant resource that would be affected by the levee alternative is the historic Portage Canal and, in particular, the lock at the Wisconsin River. A strong, very vocal group of local citizens is working to restore the canal to navigability by recreational craft. While this may prove to be unfeasible, there is no question as to the historic importance and recreational potential of the lock and canal. The design of this alternative at the lock will be critical to preserve the historic integrity of the site and to provide for recreational use of the lock and canal. (See cultural resources appendix for additional information.)

Three other parks would be affected by the levee alternative. The first is Pauquette Park, located just upstream from the Highway 33 bridge. The existing Portage levee divides the park. The landward portion has a large, irregularly-shaped reflecting pond crossed by a small bridge. There are various pieces of playground equipment on top of the levee and on the riverward side. Also riverward of the levee is an asphalt basketball court, a picnic shelter, and an informal ball diamond. Which facilities would be affected depends on the extent of the levee raise. Current planning assumes all levee raising and widening would occur riverward. Therefore, it is apparent that the basketball court and the play equipment would have to be relocated. The picnic shelter and area may also be affected. The landward side of the levee should not be affected.

The second area that would be affected is a boat launching ramp just upstream of Pauquette Park. The site consists of a boat ramp directly off the city street. The current levee plans would raise the city street and may make the ramp unusable because of a too-steep slope. As the plans become more refined, it should be possible to incorporate the ramp into the road raise; however, the ramp area may have to be relocated. Given the expressed need for access to the State's waters for fishing, boating, and canoeing, this ramp should be replaced.

The third area is Riverside Park and the existing levee downstream of the Portage Canal. Riverside Park is located along Highway 16 and provides an off-road parking and picnic area. It is an attractive area with many trees. The existing Portage levee separates the park from the Wisconsin River. The levee from the canal downstream through the city has a path on it, with benches. In the area of Riverside Park, picnic tables have been provided. The levee alternative would raise and widen the existing levee throughout this area. However, as all work would be riverward, Riverside Park should not be affected. It is assumed the tables and benches could be replaced on top of the new levee.

Recently, the Wisconsin River main channel shifted from the left or Portage side to the right side. As a result, during periods of low water, large expanses of sand are exposed near Portage. These areas have been used for recreation. The construction/reconstruction of the levees riverward could encroach on this "new" recreation area. Also, the area may be used as a borrow area for levee material. However, the overall effect is difficult to determine because, although unlikely, the river could, at any time, reclaim its former channel. In addition, the shifting of the channel and the resulting extensive shallow areas of the Portage Canal could make navigation restoration more difficult.

RECOMMENDED PLAN

FLOOD CONTROL ALTERNATIVE

On the basis of information to date, the recommended flood control plan is improvement of the Portage levee alternative. This alternative has been further refined to provide for preserving the integrity of the Portage Canal Wisconsin River Lock. This includes a raised levee from the downstream end near the lock structure, the lock gates replaced with gates designed for freeboard closure when needed, a floodwall built into the upstream lockwall and extending approximately 550 feet upstream, and then almost a continuous levee to Pauquette Park. From a recreation standpoint, this would provide the needed flood protection while preserving the integrity and potential of the Portage Canal.

The specific effects of this plan on the recreation resources would be the same as those discussed in previous paragraphs.

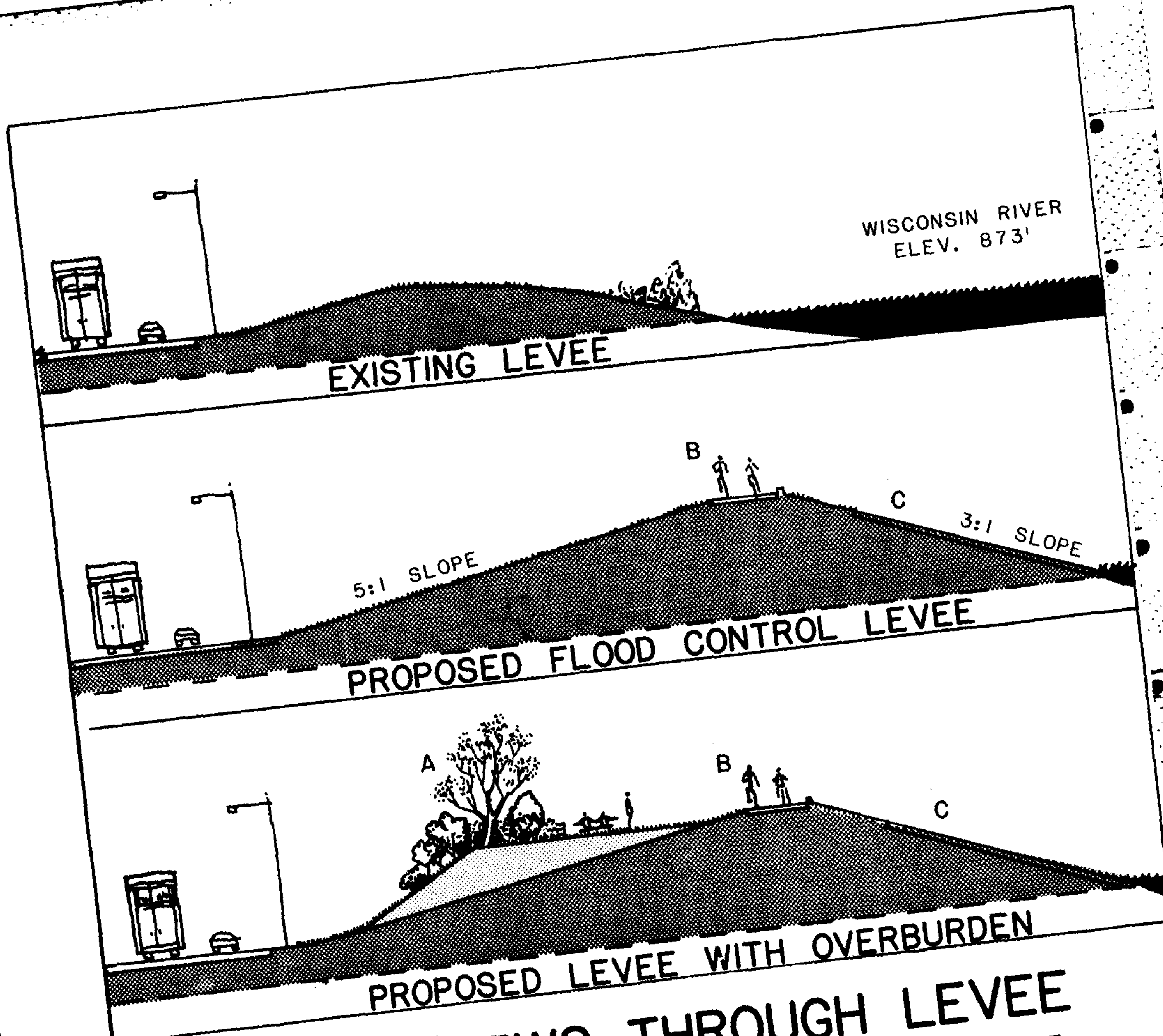
CONCEPTUAL RECREATION PLAN

The conceptual recreation plan described in the paragraphs below was developed on the basis of existing and potential recreation uses of the project area; the expressed recreation needs of the city, county, and region; and the

recreation potentials of the flood control measures being proposed. When possible, estimates of potential visitation, recreation benefits, and costs are developed. The conceptual plan is based on the proposed alternative plan incorporating the existing lock structure. This alternative plan offers the most potential for recreation.

The proposed recreation plan would consist of the following elements: a paved bicycle/pedestrian trail along the top of the levee between the Portage Canal and the project's downstream terminus at U.S. Highway 16 and County Road G; an expanded Riverside Park area; an interpretive/information display at the Portage Canal; relocation and reorganization of facilities at Pauquette Park; and redevelopment of the boat launching area near Summit and Carroll Streets (plate 2).

The proposed trail would have two segments, with Riverside Park serving as an intermediate point. There is currently a lack of good public access to and parking at the canal. Therefore, this plan proposes to use Riverside Park as an access point to the lock area of the canal via a trail on the levee. Signs at the park would direct visitors along the trail to the canal. The trail between the park and the canal would be approximately 1,800 feet long. The other segment of the trail would be approximately 12,000 feet long and extend from the park to the downstream end of the project. This segment should provide a desirable alternative to bicycling or walking along the highway. The top width of the levee would be 10 feet, which would allow for an 8-foot trail width. In addition to the trail, benches and picnic tables could be provided in overburdened areas along the top of the levee. These trails would help meet the trail needs of the region (figure 1).



SECTION VIEWS THROUGH LEVEE

NO SCALE

A PLANTS WITH SHALLOW FIBROUS ROOTS ONLY

B TRAIL ON TOP OF LEVEE

C RIPRAPPED BANKS

FIGURE 1

A barrier would be provided along the riverward side of the trail. Rather than a physical barrier that would prevent trail users from going down to the river, it would be a low barrier to provide a sense of where the edge is. A physical barrier, such as a high guardrail or fence, would interfere with levee maintenance. The proposed barrier could be an asphalt curb, the concrete curb sections used in parking lots, or bollards or small shrubs or the like in any combination.

Riverside Park could be expanded by using overburdened areas to provide for additional picnicking units and for landscaping. Signs would be provided directing trail users and visitors to the Portage Canal and other points of interest. Railroad tie stairs could be incorporated into the levee to provide access to the top of the levee. Portions of the trail would come down from the levee into the park. The expanded park would help meet the need for additional picnicking facilities.

The Portage Canal and its Wisconsin River Lock is the most significant resource within the project area. However, its potential is greatly reduced because of very limited public accessibility, especially parking. Therefore, the proposed development of this area is limited, in keeping with the accessibility. The only facility proposed for this area is an interpretive/informational display. There are four themes or story lines that could be presented at this location: (1) the history of the Wauona Trail, the establishment of Fort Winnebago, etc.; (2) the history and operation of the Portage Canal and its locks; (3) the history of the city of Portage; and (4) a description of the flood control project. (See Cultural Resources Appendix for additional information and figure 2.)

PROPOSED INTERPRETIVE INFORMATION DISPLAY

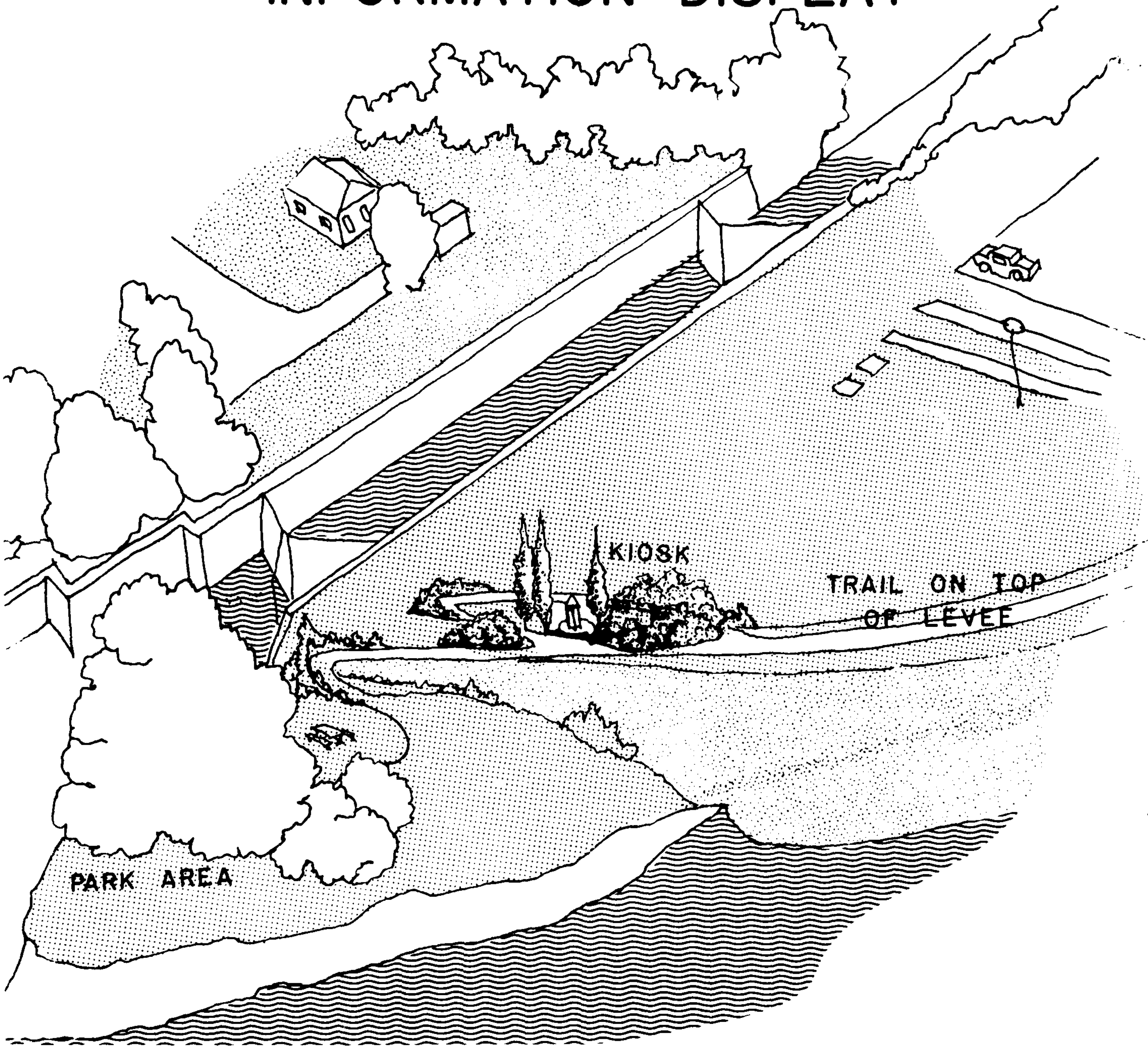


FIGURE 2

The levee through Pauquette Park, which currently divides the park into a rather quiet area around the pond and an active area with the basketball court and picnicking facilities, would be raised. This would require relocating the court and some, if not all, of the play equipment, and the picnic units. This would provide an opportunity to reevaluate the area and to possibly reorganize the uses in the "active" area of the park. For example, the intersecting slopes of Conant Street and the levee would provide a natural seating area for a ball diamond. It would appear that all existing site uses could remain in the park.

The existing boat launching ramp would be difficult to use because of required road raises. It is proposed to incorporate a launching area into the project.

No facilities are proposed for the portion of the upstream levee outside Pauquette Park or along the floodwall.

CORPS-LOCAL RESPONSIBILITIES

The Corps of Engineers has the authority to enter into a cost-sharing agreement with local units of government to provide recreation facilities at its projects. The Corps involvement is restricted to those lands required for purchase in fee for the proper operation of the project. At Portage, Corps involvement would be restricted to the levee right-of-way. Specific Corps involvement at Portage will be discussed in later paragraphs.

The following items briefly describe the current policies of the Corps regarding recreation development:

1. Recreation developments will be provided within the lands acquired by local interests in fee for the basic flood control project, except as may be required for access, parking, potable water, sanitation, and related developments for health, safety and public access. Development on less than fee lands must have prior approval from the Office of the Chief of Engineers; for example, an easement for a public trail.

2. The inclusion or exclusion of recreation will not influence the formulation of the project. Each project purpose (flood control, recreation, etc.) must stand on its own merit.

3. The overall cost for recreation cannot exceed 10 percent of total project costs without prior approval of higher Corps authorities.

4. Certain types of recreation facilities are excluded from Corps participation. These facilities include: decorative fountains; boat docks, piers, marinas, etc.; stores, restaurants, etc.; and administrative buildings.

5. Before recreation development can be undertaken in connection with structural local flood control projects, a non-Federal public entity must enter into a formal recreation cost share agreement with the Federal Government (Corps). Any agreement to participate with a non-Federal entity in the development of outdoor recreation opportunities at local flood control projects will require that the non-Federal entity:

a. Acquire in its name and dedicate to public outdoor recreation use for the economic life of the basic flood control improvement all separable lands required for recreation development and needed to ensure public control of the development, with credit as in "b" below.

b. Where the appraised value of the separable recreation land so provided amounts to less than 50 percent of the total first cost of the recreation development, make additional contribution sufficient to raise the non-Federal share to at least that level; such additional contribution may consist of the actual cost of carrying out an agreed upon portion of the development, a cash contribution, or a combination of the above.

c. Operate, maintain and replace, without expense to the Federal Government, the recreation areas and all facilities installed pursuant to the agreement.

6. Current policy requires the local sponsors to provide their financial contribution upfront.

In regard to 5. above, the local sponsor does not sign the agreement until the project is authorized by Congress, all other agreements have been signed, and construction is about to begin. At this stage of the planning process, the potential local sponsors need only indicate that they are interested in continuing to plan for the inclusion of recreation (plate 3). In later planning and design, firmer commitments from the local sponsors are required.

At Portage, the Corps participation for the various plan elements described previously would be as follows:

1. Trails - The Corps could participate in the development of the entire levee trail system, to include the overburdened areas, benches, and picnic tables.

2. Riverside Park - The proposed expansion of the park onto the landward slope of the levee would be eligible for cost sharing. In addition, as this park would provide access to the project, it may be in the interest of public health and safety to furnish restrooms and drinking water within the existing park area. These facilities may be eligible for Corps participation. This item should be investigated in later planning stages.

3. Portage Canal - The proposed interpretive/informational display would be eligible. Within the scope of this flood control project, the Corps cannot work with the city to restore the lock and canal to navigability.

4. Pauquette Park - Relocation of the facilities displaced by the raised levee would be the responsibility of the city. The Corps can provide information on how the park area could be reorganized and modify the levee design to accommodate recreation.

5. Boat launching area - While the relocation of facilities is a local responsibility, the launching ramp may be incorporated into the road raise design. This possibility should be studied in detail in later planning stages.

SPECIAL PROBLEMS

Land and Water Conservation (LAWCON) Funds were used to provide lighting and a basketball court at Pauquette Park. Each of the proposed flood control alternatives would require raising of the existing levee through the park.

The potential exists for section 6(f) conflict as defined in The Land and Water Conservation Fund Act of 1965, as amended.

Paragraph (3) of Section 6(f) states, "No property acquired or developed with assistance under this section shall, without the approval of the Secretary, be converted to other than public outdoor recreation uses." The Secretary referred to is the Secretary of the Interior. Section 6 describes the funding appropriation procedures, conditions, etc.

Should it be determined by, first, the State Liaison Officer for LAWCON and, ultimately, the Department of the Interior (the National Park Service is the current reviewing authority) that a proposed project would be a conversion of a LAWCON funded park, then it would be necessary to acquire replacement lands. In the case of a Corps project such as at Portage, the local sponsor would be responsible for acquiring the replacement lands.

At this stage in the planning process, it appears that the proposed changes to the existing levee would not change (convert) the uses of the park area. Some relocations of facilities would be required; however, the facilities should be able to remain within the park. Subsequent study efforts will more clearly define the extent of the levee's effects.

ECONOMIC JUSTIFICATION

The Corps cannot participate in development of recreation facilities that are not economically justified; that is, the public benefits they would generate must outweigh the costs to construct, operate, and maintain them. The following paragraphs evaluate the potential visitation, estimate the recreation benefits and associated costs, and determine the benefit to cost ratio. At this level of detail, the estimates are based on gross assumptions, and these estimates will need to be refined in subsequent reports.

The only plan elements eligible for cost sharing are the levee trails, expansion of Riverside Park, and the display at the Portage Canal. Eligibility of the boat launching areas cannot be determined until more detailed design information is available. Therefore, potential visitation and estimated benefits and costs have been developed only for that portion of the project from the Portage Canal to the downstream terminus.

POTENTIAL VISITATION

The trail system as proposed would offer opportunities for bicycling, walking, jogging, roller skating, and cross-country skiing. It is difficult to predict the potential use of a facility for these activities because of a lack of reliable data. Most of these activities are relatively new and/or growing rapidly. For example, the growing interest in fitness and wellness has generated considerable interest in running which could not be predicted a few years ago. One potential trail use for which participation has been projected is bicycling. For this report, it will be assumed that bicycling is the only trail activity.

The 1977 Wisconsin SCORP projects bicycling activity occasions for an average weekend day by region. By assuming that the use on an average weekend day is 35 percent of the total week's use, and that there are 20 weeks in the bicycling season, one can derive the total annual bicycling occasions for the region. Dividing these occasions by the regional population yields the

regional per capita use rate (PCUR). For region 2, this method yields a 1980 PCUR for bicycling of 1.6 (each resident of the region went bicycling, on the average, 1.6 times in 1980). There are reasons to believe that the PCUR could be grossly underestimated. Bicycling has grown quite rapidly since the data for the SCORP projections were gathered. Second, the State of Minnesota, in its 1979 SCORP, reported a statewide PCUR for bicycling in excess of 10, and State officials believe that PCUR is an underestimate. Therefore, for this report, a PCUR of 5 will be used. This may still be a very conservative estimate of bicycling, and, because it does not consider the other possible trail uses, of the potential use of the levee trails.

The potential visitation estimates are based on the following:

- The 1980 population of Portage is 7,896 (1980 U.S. Census)
- Per capita use rate for bicycling is 5.0
- 15 percent of all bicycling would occur on the proposed trail system
- 75 percent of all trail use is by Portage residents
- Bicycling occasions would increase 5 percent between 1980-85, 1985-90, and 1990-95 (1977 Wisconsin SCORP)

Potential visitation = (1980 population x PCUR) x percent of use on trail ÷ percent of total use that is local users = ((7,896 x 5.0) x 0.15) ÷ 0.75 = 7,896, say 7,900 visitors in 1980.

Figure 3 shows estimated visitation for the life of the project, assuming the project was built in 1983.

Figure 3 - Potential visitation

Year	Visitation
1983	0
1985	8,245
1990	8,700
1995	9,135
2083	9,135

RECREATION BENEFITS

Using the unit-day value methodology for determining benefits as described in ER 1105-2-300, July 1980, a value of $2.94 was derived. Using standard discounting techniques, an average annual recreation benefit of $24,950.47, say $25,000, was calculated (100-year project economic life and an interest rate of 8-1/8 percent).

The recreation benefits calculated considered only bicycling among the potential trail uses. Also, they did not take into account visitors to the project who utilize Riverside Park, or go directly to the Portage Canal.

COST ESTIMATE

Figure 4 provides a rough estimate of the costs associated with the proposed recreation facilities. The estimate was based on the following assumptions:

- The trail would be 8 feet wide and paved with asphalt.
- The riverward side of the trail would have a low "barrier" to provide a visual boundary for safety reasons. A physical barrier to prevent users from going down the riverward slope would be prohibitively expensive and would interfere with project operation and maintenance.
- The levee would be overburdened to provide for picnic unit and bench placement.

Figure 4 - Cost estimate

Item	Unit	Quantity	Unit cost	Total
Trail, asphalt-paved	L.F.	15,000	$ 5.00	$ 75,000
Trail edge barrier	L.F.	15,000	2.00	30,000
Benches	Ea.	5	100.00	500
Picnic units	Ea.	5	250.00	1,250
Levee overburdening	Ea.	10	5,000.00	50,000
Interpretive/ information display	Ea.	1	10,000.00	10,000
Signs	Job	Sum	500.00	500
				167,250
Contingencies (20 percent)				33,450
Subtotal				200,700
Engineering and design (12 percent)				24,100
Supervision and administration (5 percent)				10,000
Overhead				
On engineering and design (13 percent)				3,100
On supervision and administration (13 percent)				1,100
Total cost				239,000

The total construction cost estimate of $239,000 converts to approximately $19,400 annual cost, based on an interest and amortization factor of 0.08128.

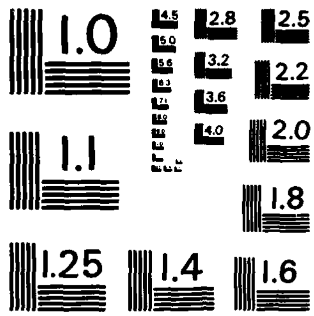
BENEFIT-COST RATIO

A comparison of average annual benefits and average annual costs follows:

$$\$25,000 \div \$19,400 = 1.3$$

AD-A148 351 FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT WISCONSIN RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 83 8/9

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

The proposed recreation plan appears justifiable at this level of detail. It should be noted that the benefits are probably underestimated. Additional work will be required in subsequent planning stages to refine both the potential benefits and costs.

LANDSCAPE BEAUTIFICATION

This section describes some of the alternative measures available to restore and enhance the project area during and after construction. It is the policy of the Corps to design its project features so that the visual and human-cultural values associated with the project will be protected, preserved, maintained, or enhanced to the maximum extent practicable. Some of the measures that could be used at Portage include architectural treatments to the flood control structures, healing of construction scars, management of vegetation, and landscape planting. As a general rule, approximately 3 percent of the total construction budget can be used for this effort. These costs are shared between the Corps and the local sponsor according to the cost sharing formula being used for the particular feature with which it is associated.

There is no intent to establish a recommended plan for beautification at this point in the planning process. Most decisions need not be made until the plans and specifications phase prior to construction. However, it is important for all parties in the planning process to be aware of what is possible and how each group envisions the final product to look.

The recommended plan consists of two basic elements: levees and a floodwall. Each has its own visual effects and potentials. The levees will need a vegetative cover to protect them, but that cover cannot interfere with the operation of the levee during floods. The floodwall does not require protection, yet various treatments, both architectural and landscape, are often used to blend the floodwall into its surroundings. The following

paragraphs briefly describe what could be done with the levees and floodwalls. These descriptions are not all inclusive, but present ideas to the study participants on project beautification.

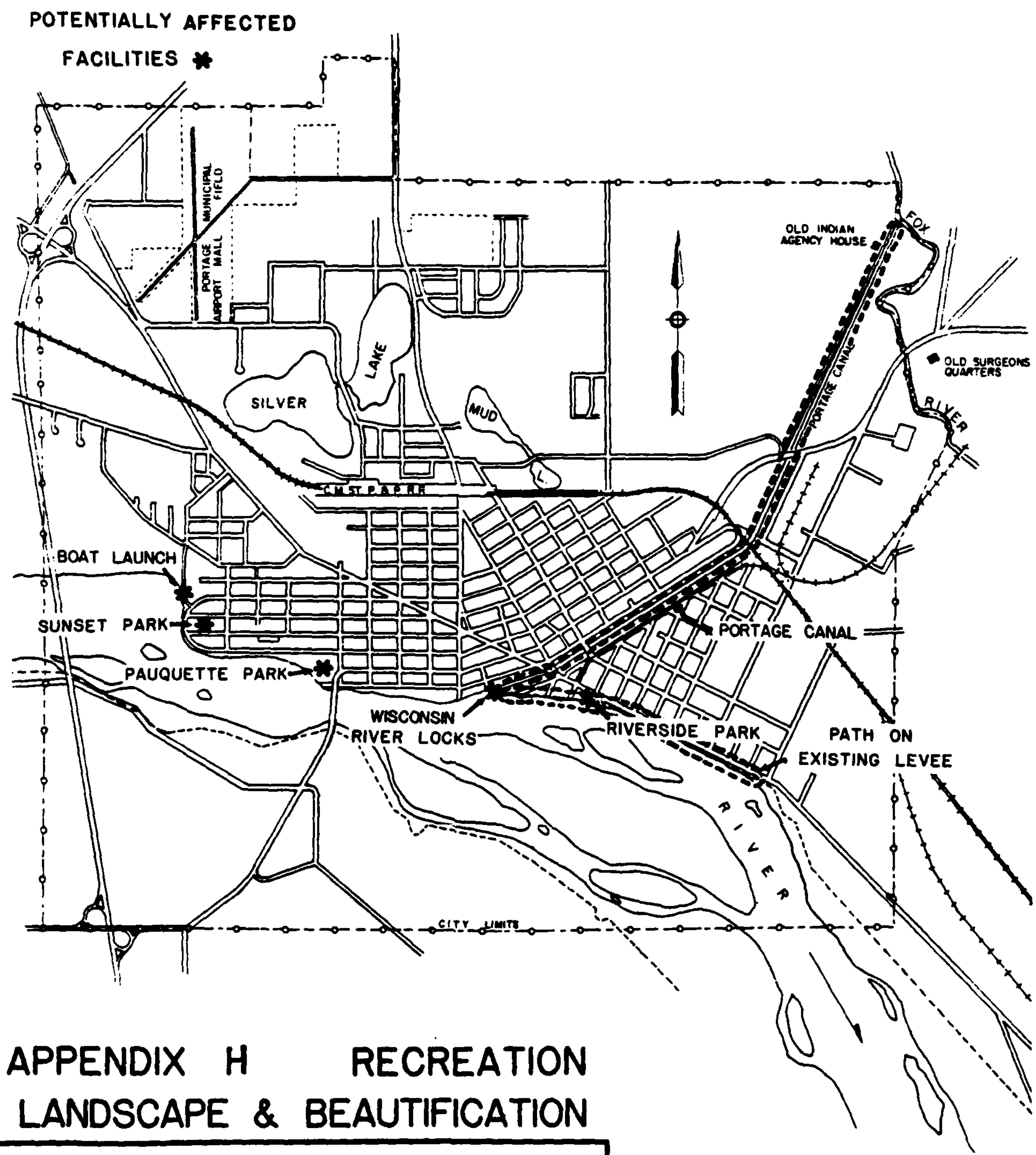
Levees are often covered with low grasses to permit inspection of the levees, allow easy access anywhere on the levee, and for hydraulic considerations. The root zone of the plants is the most important factor. The channels the roots make as they grow represent potential channels that floodwater could follow. Hence, long, deep roots could allow water to penetrate the levee, leading to possible failure. Therefore, plants with shallow roots are preferred. Larger plants and/or plants with deep root structures can be used on a levee if the levee is overburdened or warped; that is, additional material is placed on the levee to allow for the roots without penetrating the core of the levee. However, overburdening is not always structurally possible.

The levees at Portage offer a variety of situations in terms of location and potential recreation uses which influence the choices of plant materials to consider. Another factor is maintenance. The levee from Ontario Street downstream parallels the highway with little development on the other side of the highway. In this area, plants usually used along highway back slopes, such as crown vetch, clover, and short grass prairie species, would be appropriate. Within the developed urban area (the canal to Ontario Street), a more manicured appearance may be desirable. Therefore, blue and rye grasses may be more appropriate. However, the maintenance requirements for those species would be greater. For Riverside and Pauquette Parks and the lock area, the "mowed lawn" look is probably the most desirable.

Small trees and shrubs could be placed along the levee to provide variety. These could be provided in overburdened areas.

The floodwall presents its own opportunities. The landward side would be the "back fence" for the residents of the area, while the riverward side would be viewed as an extension of the existing lock wall. The appearance of the wall can be altered by architectural and/or landscape treatments. The physical appearance of the wall can be changed by using colored concrete to match the lock wall and/or by using the concrete forms to create patterns. Various trees and shrubs could be planted along the landward side to visually break up and/or screen the floodwall. Whatever is done along the landward side will have to be coordinated with the neighboring residents.

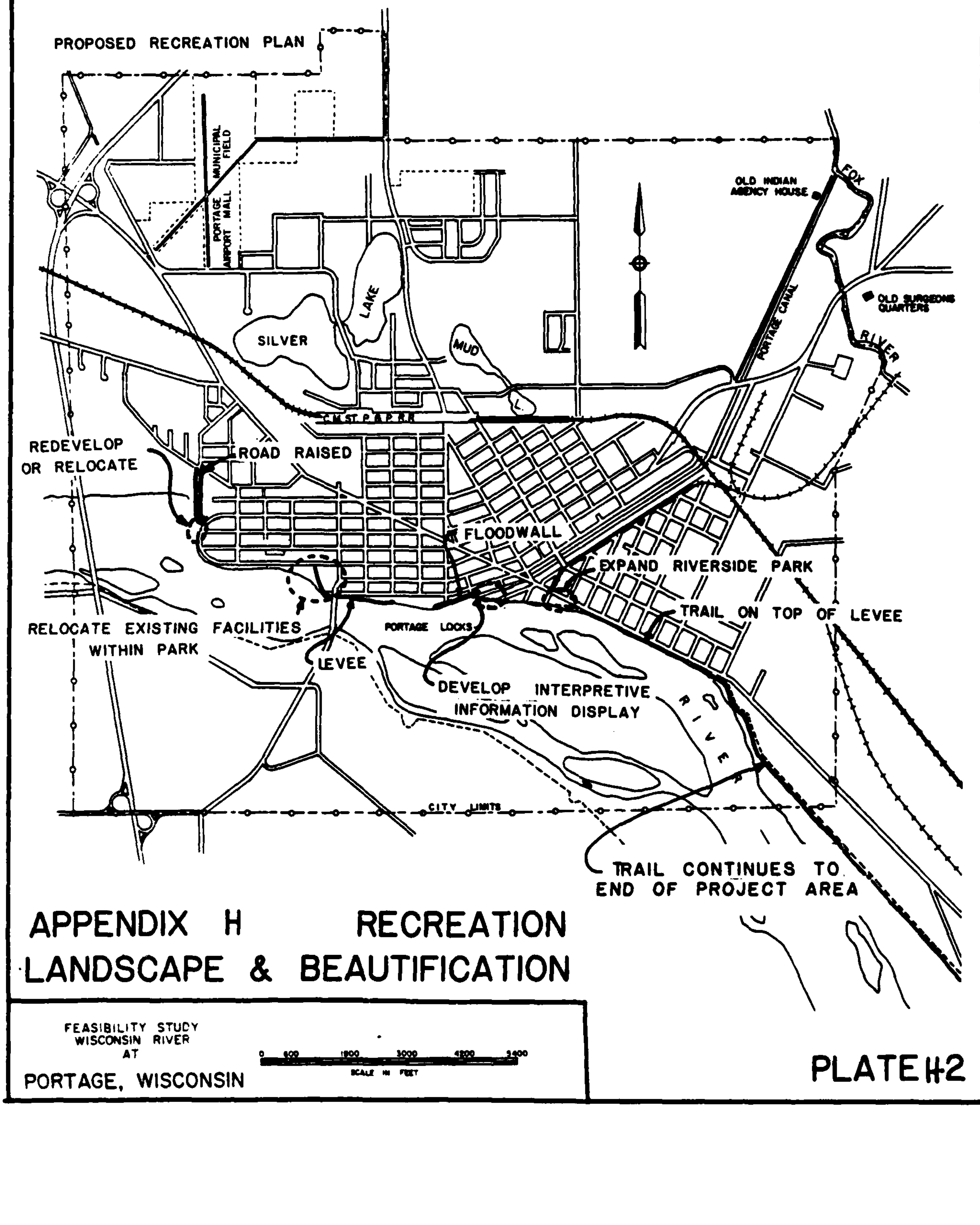
The most important consideration in landscaping the project is that the structural and operational integrity of the project features be maintained.



APPENDIX H RECREATION
LANDSCAPE & BEAUTIFICATION

FEASIBILITY STUDY
WISCONSIN RIVER
AT
PORTAGE, WISCONSIN

PLATE H-1



APPENDIX H RECREATION LANDSCAPE & BEAUTIFICATION

FEASIBILITY STUDY
WISCONSIN RIVER
AT
PORTAGE, WISCONSIN

0 600 1800 3000 4200 5400
SCALE IN FEET

PLATE H-2

CITY OF PORTAGE

"Where the North Begins"

● PORTAGE, WISCONSIN
53901

DEPARTMENT of PARKS and RECREATION

November 30, 1983

115 West Pleasant Street
Portage, Wisconsin 53901

Colonel Edward G. Rapp
District Engineer
1135 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Sir:

I am writing in regard to the Portage Flood Control Project.

Having reviewed the U. S. Army Corps of Engineers Feasibility Study for Flood Control at Portage, Wisconsin dated March, 1983, I have found the Portage Park and Recreation Department is in favor of the proposed recreation features of the project and that we should continue to cooperate with the Corps to develope a plan that both parties will agree on. We also understand that if a mutually agreeable plan is developed, cost sharing agreement responsibilities would have to be negotiated.

If you should have any questions please contact my office.

Thank you for your time and consideration.

Best regards,

J. E. Davis

Jefferson E. Davis
Parks and Recreation Director

JED:lm

cc: Mayor Smith
Michael T. Horkan, City Engineer
Donald F. Anacker, Chairman, Park & Recreation Board

FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER
at
PORTAGE, WISCONSIN

APPENDIX I

DESIGN AND COST ESTIMATE

December 1983

APPENDIX I
DESIGN AND COST ESTIMATE

TABLE OF CONTENTS

FIGURES

PLATES

APPENDIX I

DESIGN AND COST ESTIMATE

STRUCTURAL DESIGN

Structural features for the selected plan were developed using appropriate engineering, design, and geotechnical investigations. For the levee, floodwall, and road raise features, the analysis included stability, seepage and uplift, and structural adequacy. The levee configuration will have 1V on 3H riverward slopes (except, to limit encroachment into the canal area, a 1V on 2½H will be used), 1V on 5H landward slopes, and a minimum top width of 10 feet. A seepage berm (at the downstream end of the project), a perforated pipe (near the Portage Canal Lock), and sheet piling (beneath the floodwall) will be used to reduce uplift or possible exit gradient problems. The levee top width will be increased to accommodate the road raise in the Summit Street area. New gates at the upper end of the Wisconsin River Lock and additional structural modifications at the lock are necessary to provide design flood protection.

The existing lock was analyzed and checked for sliding and overturning in 2 cases: first, flood water to elevation 798.7 outside the lock, and water inside the lock to elevation 779. Second, water level at elevation 783 and the lock dewatered. Case 1 proves stable with the resultant inside the kern. In case 2 the resultant is outside the kern but concrete stresses are not excessive. In both cases sliding is taken care of by shear keys. The stability analysis assumed weep holes were operational in the lock floor. For the analysis a saturated soil of 130 pcf with $\phi = 30^{\circ}$ was assumed. The assumed dimensions of the lock were taken from a USACE drawing entitled "Fort Winnebago Lock and Portage Lock and Canal" dated June 30, 1957.

The plan at the lock area makes it possible to operate the lock after modification. However, the new lock gates provide a flood barrier and prevent water from entering the town through the lock and channel.

Care was taken to maintain the historical value of the lock. This would mean that alteration should be either minimal or unnoticeable. Existing lock hardware and machinery should be salvaged when possible.

Dewatering will be done to facilitate modification. This would be accomplished by filling the channel upstream and downstream of the lock with fill on site and pumping to dewater. Earth would be removed from the channels at the end of construction.

The floodwall required upstream of the lock is to eliminate the problem of a levee encroaching on the lock channel. A railroad closure structure is needed in the downstream end of the project. Plates I-1 and I-2 show design considerations.

DETAILED COST ESTIMATE

A detailed cost estimate for the selected plan is presented in the following figure. The unit costs are based on prices adjusted to reflect average bid prices received on similar work by the St. Paul District. The costs are based on October 1983 prices, and an additional allowance of 20 percent for contingencies has been added to the estimated costs. The estimated land costs per acre were obtained from the Corps of Engineers, North Central Division Real Estate Office and are based on fee simple title of comparable sales and listed properties.

Detailed cost estimate, Portage flood control project

Item	Unit	Quantity	Unit cost	Total cost
First cost				
Levees and floodwalls				
Levees				
Clearing and grubbing	Acre	6	$1,500.00	$ 9,000
Stripping, 6-inch	CY	44,480	3.00	133,440
Inspection trench	CY	41,850	7.40	309,690
Levee fill	CY	327,400	2.65	867,610
Berm fill	CY	146,400	2.65	387,960
Topsoil, 4-inch	CY	38,400	3.50	134,400
Seeding	Acre	69.6	900.0[illegible]	62,640
Riprap	CY	30,810	18	554,580
Bedding	CY	15,160	1[illegible]	166,760
Contingencies (20 percent)				524,920
Total levees				3,151,000
Road Raise and Ramps				
Stripping	CY	2,570	3.00	7,710
Clearing and grubbing	Acre	1	1,500.00	1,500
Road fill	CY	34,000	2.65	90,100
Road ramps	CY	733	12.00	8,796
* (Summit Street area)	SY	24,000	6.25	150,000
Road ramp	CY	18,170	12.00	218,000
* (U.S. Highway 51)	SY	25,000	6.25	156,250
Topsoil, 4-inch	CY	2,000	5.25	10,500
Seeding	Acre	2.5	1,150.00	2,875
Contingencies (20 percent)				133,269
Total road raise and ramps				779,000
Floodwalls				
Floodwall, 550-foot	Job	Sum	-	398,100
Lock area work	Job	Sum	-	185,087
Install lock gates	Job	Sum	-	8,632
Contingencies (20 percent)				118,181
Total floodwalls				710,000
Closure Structures				
Canal (plywood closure)	LF	54	1.85	100
Highway 51 (sandbag closure)	LF	48	9.00	432
Railroad (stoplog closure)	Job	Sum	-	186,000
Contingencies (20 percent)				37,468
Total closure structures				224,000
Total Levees and Floodwalls				4,864,000

Detailed cost estimate, Portage flood control project (continued)

Item	Unit	Quantity	Unit cost	Total cost
Drainage Facilities				
Area A				
36-inch RCP	LF	740	$ 140.00	$ 103,600
36-inch sluice gate	Ea	2	5,850.00	11,700
Gatewell	Ea	2	5,000.00	10,000
Pumping station (4,000 gpm)	Job	Sum	-	130,000
48-inch RCP	LF	500	170.00	85,000
2 manholes	Job	Sum	1,800.00	3,600
Contingencies (20 percent)				68,100
Total Area A				412,000
Area B				
42-inch RCP	LF	80	150.00	12,000
42-inch sluice gate	Ea	1	8,000.00	8,000
Gatewell	Ea	1	4,700.00	4,700
6-inch perforated PVC	LF	700	7.00	4,900
Portable pump (600 gpm)	Job	Sum	-	2,500
Contingencies (20 percent)				5,900
Total Area B				38,000
Total drainage facilities				450,000
Total landscaping and aesthetics	Job	Sum	-	8,000
Total construction costs				5,322,000
Engineering and design (15 percent)				798,000
Supervision and administration				250,000
Inspection, 25 percent of E and D				(200,000)
Overhead, 25 percent of Inspection				(50,000)
* Total recreation facilities(1)				239,000

Detailed cost estimate, Portage flood control project (continued)

Item	Unit	Quantity	Unit cost	Total cost
* Real Estate				
Lands, values and damages				
(84.37± acres - perpetual flood protection levee, easement, and fee for recreational use areas)				317,000
(3.0± acres - perpetual easement to occasionally overflow, flood, and submerge)				1,000
Improvements (2 residences)	Job	Sum	-	60,000
PL 91-646 Relocation Payments	Job	Sum	-	30,000
Administrative (est. 42 owners)	Job	Sum	-	105,000
Contingencies (20 percent)				77,000
Total real estate				590,000
* Relocations				
Utility poles	Ea	29	525.00	15,300
Gas line	LF	650	26.00	16,900
Contingencies (20 percent)				6,800
Total relocations				39,000
Total first costs				**7,238,000**

(1) Includes 50-percent non-Federal contribution.
(*) Items requiring local cost sharing under traditional Corps policy.

ESTIMATE OF ANNUAL CHARGES

Annual charges of the selected improvements are based on an interest rate of 8-1/8 percent and an amortization period of 100 years. Included in the annual charges is an allowance for interest during an assumed 2-year construction period. Maintenance and operation of the proposed improvements are based on cost data available for similar work throughout the country plus added maintenance attributable to the project modifications. Estimates of the average annual maintenance, operation, and replacement costs and a summary of the estimated annual charges for the flood protection plan at Portage, Wisconsin, are shown on the following figures.

Estimates of additional annual maintenance, operation, and replacement costs

Item	Annual cost
Replace pumps(1)	$ 2,000
Annual power charges	200
Levee maintenance	7,400
Pumping plant operation	400
Total	10,000

(1) Amortized costs based on 35-year life.

Estimated annual charges

Item	Annual charges
Total first cost	$7,238,000
Interest during construction	700,000
Total project investment	7,938,000
Interest and amortization(1)	645,000
Operation, maintenance, and major replacements	10,000
Total annual charges	655,000

(1) Interest and amortization for 100-year life at 8-1/8 percent. Interest rate = 0.08128.

COST SHARING

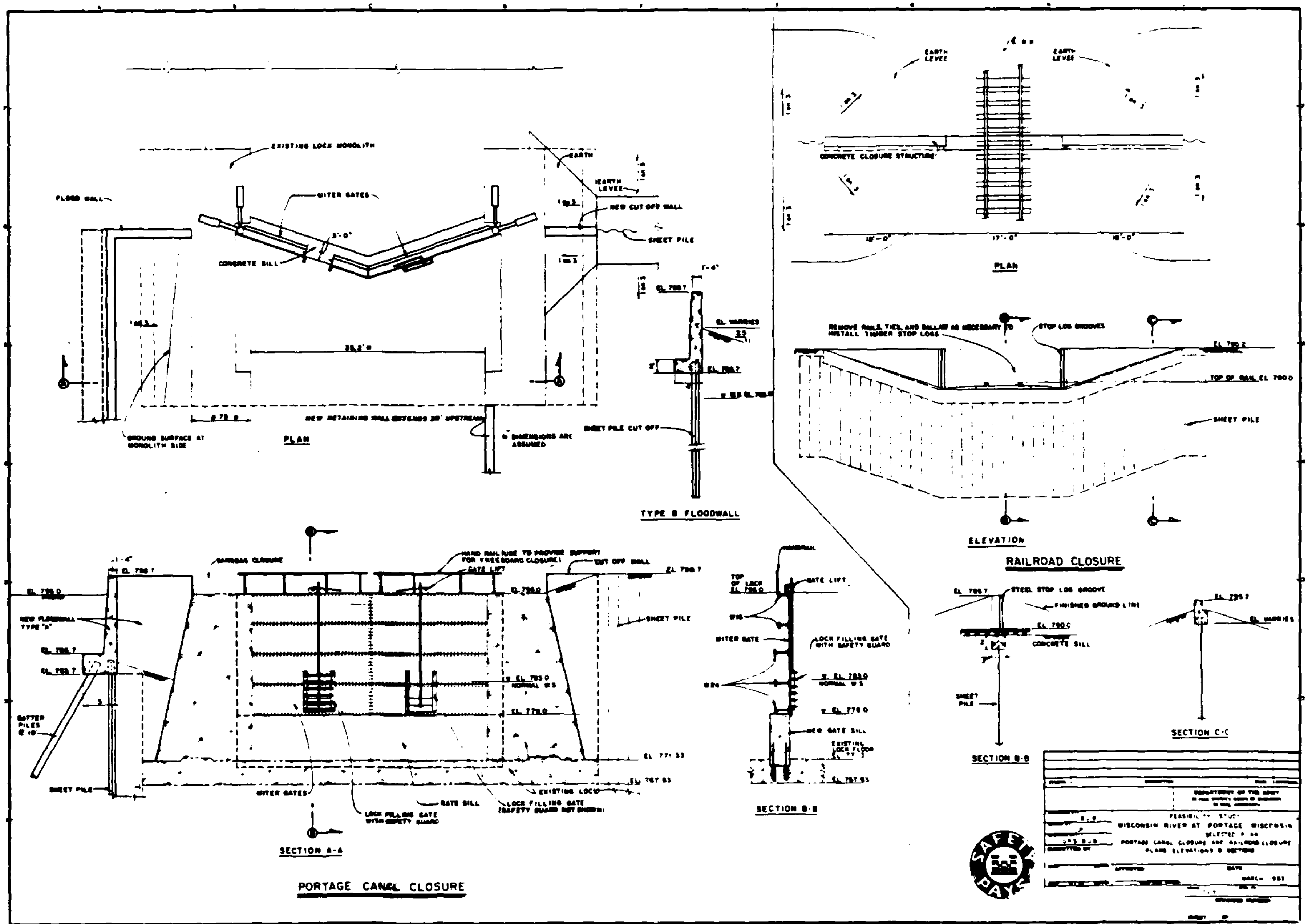
Under the traditional Corps of Engineers cost sharing policy established by the 1936 Flood Control Act, local interests are required to provide all lands, easements, rights-of-way, and all alterations and relocations to utilities, roads, etc.; hold and save the United States free from damages due to the construction works; and ensure operation and maintenance of the works after completion. Using this policy the figure below shows a Federal/non-Federal breakdown of the estimated detailed costs presented earlier in this appendix. Costs shown as non-Federal in the following figure (under traditional policy) are asterisked (*) for identification in the earlier table. Non-Federal costs for streets and ramps include that part of the total cost required for resurfacing.

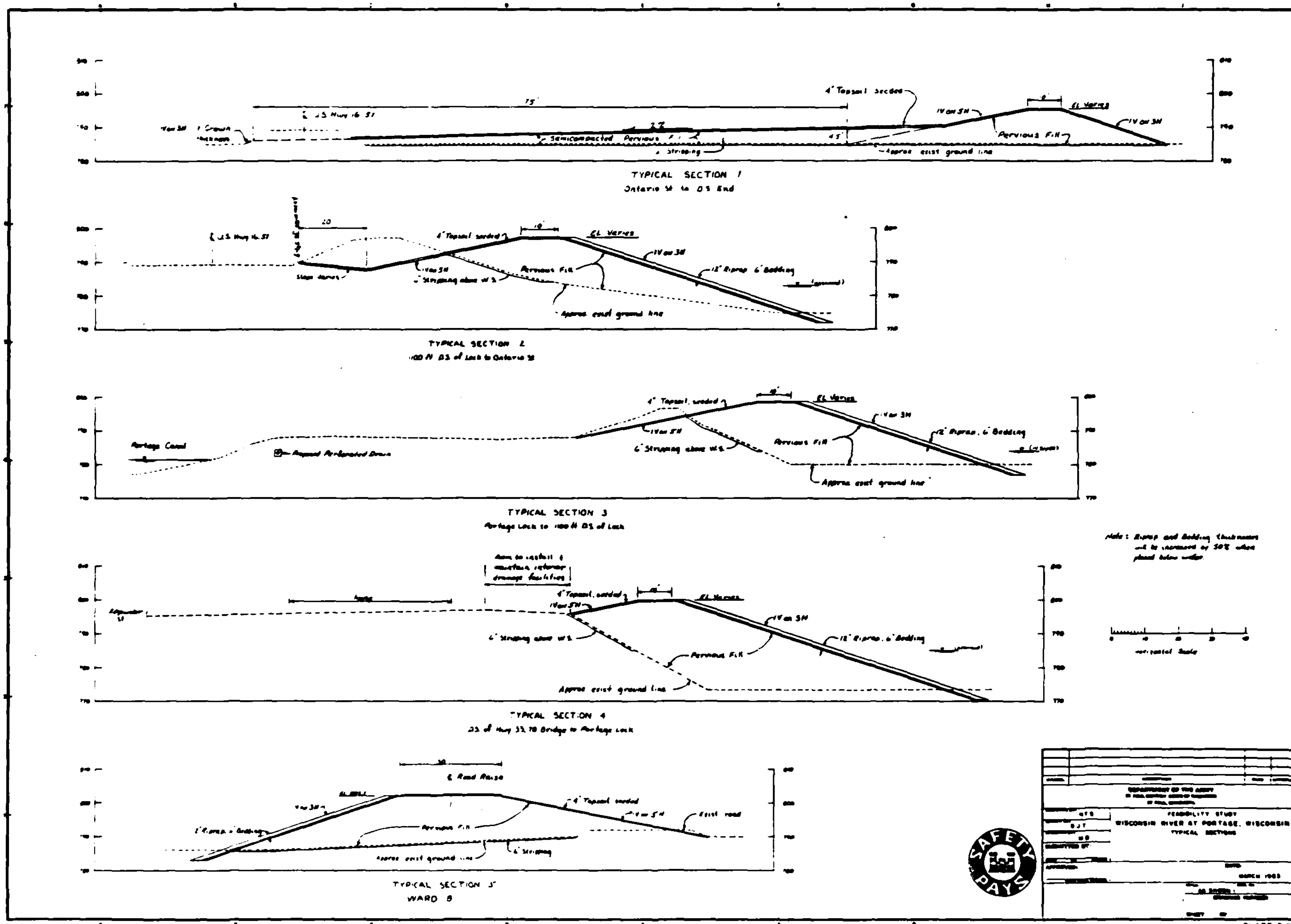
Cost sharing - Portage levee improvement

Interest	Traditional policy	Army's policy
Federal	$6,537,000	$5,160,000 (1)
Non-Federal	1,401,000 (2)	2,778,000 (2)
Total project investment	7,938,000	7,938,000

(1) Includes 65 percent of the total first costs and interest during construction.
(2) Includes non-Federal share of interest during construction.

Also shown on the figure is the "Army's" recommended cost sharing policy as proposed by Mr. William Gianelli in 1983. Under the Army's policy the local sponsors would pay 35 percent of the initial project costs and all operation and maintenance costs. The balance - 65 percent - would be the Federal share.


EXISTING LOCK MONOLITH
FLOOD WALL
MITER GATES
CONCRETE SILL
EARTH
EARTH LEVEE
NEW CUT OFF WALL
SHEET PILE
NEW RETAINING WALL EXTENDS 30' UPSTREAM
DIMENSIONS ARE ASSUMED
GROUND SURFACE AT MONOLITH SIDE
PLAN
EL VARIES
SHEET PILE CUT OFF
TYPE B FLOODWALL
SANDBAG CLOSURE
HAND RAIL (USE TO PROVIDE SUPPORT FOR FREEBOARD CLOSURE)
GATE LIFT
CUT OFF WALL
NEW FLOODWALL TYPE "A"
BATTER PILES
NORMAL W.S.
EXISTING LOCK
LOCK FILLING GATE (SAFETY GUARD NOT SHOWN)
GATE SILL
LOCK FILLING GATE WITH SAFETY GUARD
SECTION A-A
PORTAGE CANAL CLOSURE
HANDRAIL
TOP OF LOCK
MITER GATE
NEW GATE SILL
EXISTING LOCK FLOOR
SECTION B-B
EARTH LEVEE
CONCRETE CLOSURE STRUCTURE
PLAN
REMOVE RAILS, TIES, AND BALLAST AS NECESSARY TO INSTALL TIMBER STOP LOGS
STOP LOG GROOVES
TOP OF RAIL EL 790.0
SHEET PILE
ELEVATION
RAILROAD CLOSURE
STEEL STOP LOG GROOVE
FINISHED GROUND LINE
CONCRETE SILL
SECTION B-B
SECTION C-C
EL VARIES
WISCONSIN RIVER AT PORTAGE, WISCONSIN
PORTAGE CANAL CLOSURE AND RAILROAD CLOSURE
PLATE



TYPICAL SECTION 1
Ontario St to DS End
4" Topsoil seeded
1V on 5H
EL Varies
Pervious Fill
Semicompacted Pervious Fill
Stripping
Approx exist ground line
℄ US Hwy 16 51
TYPICAL SECTION 2
100 ft DS of Lock to Ontario St
4" Topsoil seeded
1V on 3H
12" Riprap 6" Bedding
Pervious Fill
Approx exist ground line
TYPICAL SECTION 3
Portage Lock to 100 ft DS of Lock
Portage Canal
Proposed Perforated Drain
4" Topsoil seeded
1V on 5H
6" Stripping above W.S.
EL Varies
1V on 3H
12" Riprap, 6" Bedding
Pervious Fill
Approx exist ground line
TYPICAL SECTION 4
DS of Hwy 33 78 Bridge to Portage Lock
4" Topsoil seeded
1V on 5H
EL Varies
1V on 3H
12" Riprap, 6" Bedding
6" Stripping above W.S.
Pervious Fill
Approx exist ground line
TYPICAL SECTION 5
WARD B
℄ Road Raise
4" Topsoil seeded
1V on 5H
Exist road
Pervious Fill
Approx exist ground line
6" Stripping
Note: Riprap and Bedding thicknesses will be increased by 50% when placed below water.
Horizontal Scale
FEASIBILITY STUDY
WISCONSIN RIVER AT PORTAGE, WISCONSIN
TYPICAL SECTIONS
MARCH 1983

PLATE I-2

FEASIBILITY STUDY FOR FLOOD CONTROL
WISCONSIN RIVER
at
PORTAGE, WISCONSIN

APPENDIX J

COORDINATION, PUBLIC VIEWS, AND CORRESPONDENCE

December 1983

APPENDIX J

COORDINATION, PUBLIC VIEWS, AND CORRESPONDENCE

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

APPENDIX J

COORDINATION, PUBLIC VIEWS, AND CORRESPONDENCE

COORDINATION

The study area encompasses the city of Portage; the adjacent townships of Lewiston, Caledonia, Pacific, and Fort Winnebago in Columbia County; and the township of Fairfield in Sauk County. Each entity within the study area has flooding concerns and has been involved in the past actions to reduce flood damages.

To assure that adequate attention was given to the water resource problems of the area and that local views were incorporated into the study, a committee was established by the city of Portage and Columbia County. The committee members included:

Name	Representing
Harold Vik (Chairperson)	Portage Citizen
Candy Bulgrin (Vice chairperson)	Caledonia Citizen
Mike Horkan	Director of Public Works, Portage
Francis W. Murphy	City Attorney, Portage
Hugo Traub	Columbia County Planning & Zoning Committee
Marcus Gumz	Fairfield Township
Sam Pate	Caledonia Citizen
Art Bailey	Sauk County
Robert Hoffer	Portage Citizen
Ed Kramer	President, WPDR radio station
Leon Heinze	Chairman, Town of Lewiston
Kenneth Scherbert	Alderman, Portage
Robert Irwin (Advisory Member)	Columbia County Planning & Zoning Administration

The committee held its initial meeting at the beginning of the study in 1976. Since that time 13 meetings have been held to discuss objectives,

concerns, progress, problems, needs, and results. The committee was also very active in obtaining funding support for fiscal year 1979 when no funds were initially included in the President's Budget.

The final committee meeting was held on 9 December 1982. The results of the study to date were presented and a thorough discussion was held concerning alternatives that could be considered further. The discussion that followed indicated that (1) committee members from areas within the county that would not benefit from or be affected by the remaining alternatives would neither oppose nor voice support for such action, (2) committee members from areas within the county that would not benefit from the remaining alternatives but could potentially be affected by them would oppose such action, (3) committee members located within the county who would benefit from the remaining alternatives would favor such action. Because of the distribution of committee members, the committee chose to go on record favoring no further action.

Public meetings were held in Portage to discuss the Feasibility Study at Portage, Wisconsin. The 30 March 1977 meeting discussed the need for and potential accomplishments of the study along with potential solutions to the problems. In addition, opinions of citizens and organizations were obtained regarding flood related problems of the study area. The 29 April 1981 public meeting summarized the results of the Stage 2 portion of the study and provided an opportunity for concerned individuals, interests, and agencies to express their views, concerns, and suggestions.

Public meeting announcements were distributed to more than 200 agencies, officials, interests, organizations, and individuals. In addition, local radio stations and newspapers were kept regularly informed of the study and study progress by the committee. Consequently, both provided public service announcements concerning the public meetings, committee meetings, and important study developments.

A meeting was held on 9 December 1982 with the Portage City Council to discuss the alternatives considered in the feasibility study. The city took no action at that meeting. However, the Common Council of the city

of Portage met on 13 December and recommended that the Corps of Engineers strongly consider improvement to the Portage levee system. The city documented this support by letter dated 17 December 1982.

The draft feasibility report and draft environmental impact statement were distributed for public review and comment on 15 July 1983. In all, 152 Federal, State, and local agencies; organizations; and individuals received copies of the report. The distribution list for these documents is provided on page J-109. This final report and final environmental impact statement incorporate comments received on the draft report and draft environmental impact statement. Copies of the letters of comment are attached to the main report.

Following distribution of the draft documents, meetings were held with the city of Portage and local interests on 1 August and 22 September 1983 to discuss the selected plan and to answer any questions raised during the review process. By letter dated 30 September 1983, the city indicated support of the selected plan and a willingness to participate financially in construction of the project. The city's one concern is the length of time it takes to initiate construction. A similar letter of support from the city for the recreation features of the selected plan was provided on 30 November 1983. A copy of each letter is provided in attachment 1 to the main report.

Coordination has also been maintained with the Wisconsin Department of Natural Resources, U.S. Fish and Wildlife Service, Portage Canal Society, U.S. Geological Survey, Wisconsin State Historical Society, Wisconsin State Historic Preservation Officer, and Advisory Council on Historic Preservation. Through this coordination the hydraulic and hydrologic analysis used to determine floodplain conditions was updated and completed; the fish and wildlife setting was established; the assessment of the impacts of the alternatives was completed; the cultural resources of the study area were documented; and the importance of a national historic landmark was established. Specifically, the cultural resource coordination resulted in a Memorandum of Agreement with the Wisconsin

State Historic Preservation Officer and the Advisory Council on Historic Preservation. A copy of this agreement is presented in attachment 1 of the main report.

PUBLIC VIEWS

An Institutional Analysis for the Wisconsin River at Portage, Wisconsin, was completed by Arndorfer Associates, Apple Valley, Minnesota, in August 1982. The report summarizes the historic litigation; presents a legal analysis of legislation that may affect the authority of institutions to implement various flood control alternatives; describes the institutional setting of the study area in terms of organizational responsibilities, objectives, and interrelations; and identifies the implementability of various actions.

This institutional analysis provided input into the flood control alternative selection process by evaluating the ability of the existing institutions to implement and operate each of the alternatives being studied. Following are the major conclusions of the analysis, relative to the alternatives:

(1) The alternative favored by most local authorities is the no action alternative. All communities except Portage and Pacific are willing to accept this alternative. Although this alternative provides no additional protection, it does maintain local cohesiveness.

(2) If a structural alternative is implemented, from an organizational perspective, raising and widening of the Portage segments is optimum. The town of Pacific is likely to be willing to carry its portion of the financial burden; however, no detailed cost information was identified.

(3) The nonstructural alternatives have little local support. The communities have developed behind the protection afforded by the existing levees; they look to structural solutions.

The following tables summarize the views of the respondents [illegible] of the proposed alternatives surveyed.

ALTERNATIVE 2
RING LEVEE AROUND WARD 1

Organization	Pre. Alt.	Benefits	Shortcomings	Impact to Organ.		Acceptability		Preferred Modifications
				Workload	Budget	Public	Politic.	
HUD		Least line of resistance	Levees get topped and damage results	No	No	Yes	Yes	Relocation is best.
FEMA		Sound engineering traditional method	If topped, the damage is high	Less	Less	DNK	DNK	
Wisconsin DNR		Can develop new lands	Possible environmental damage	Insign.	No	DNK	DNK	
Columbia County Board		None to the County	None to the County	No	No	No	No	
Columbia County Plan & Zoning		Flood protection	Development restrictions on other areas	No	No	Yes	Yes	
Columbia County SWCD		Flood protection for some areas	Leaves other areas unprotected	Yes, if erosion	Yes, if erosion	No	No	
Sauk County		Protects Portage	No protection for Sauk County	No	No	Yes	Yes	
City of Portage		Increased valuation develop lands	None	Yes, develop	Yes, taxes	Yes	Yes	
1st Ward Alder.		Increased valuation	None	Yes	Yes	Yes	Yes	
Caledonia		None	More water in town.	No	No	No	DNK	
Lewiston		None	No justification	No	No	No	No	
Fort Winnebago		Added protection	None	Yes	Yes	Yes	Yes	
Pacific		None to Pacific	Flood damage to town, highways	Yes	Yes	No	No	Implement Alternative 1.
Fairfield		DNK	Adverse affect on Pacific	No	No	DNK	Doubt it	
WRFCC		Most cost effective	Little local support; committee opposition	NA	NA	No	No	
Citizens for Sensible Zoning		None	Raise the flood level on the south side	Yes, Court	Yes, fees	No	Yes	Rebuild all or none.
Portage Canal		None	Almost destroy the Historic site	No	No	No	No	

DNK = Do not know; NA = Not applicable to this organization

ALTERNATIVE 4
CLOSURES AND WALLS

Organization	Pre. Alt.	Benefits	Shortcomings	Impact to Organ.		Acceptability		Preferred Modification
				Workload	Budget	Public	Politic.	
HUD		-	-	-	-	-	-	
FEMA		Sometimes protects	Usually not engineeringly feasible	No	No	DNK	DNK	
Wisconsin DNR		Best return on investment	Only selective protection	Minimal	Minimal	Doubt it	Doubt it	
Columbia Co. Brd.		None	None	No	No	No	No	
Columbia County Plan. & Zoning		None	Not cost effective	No	No	No	No	
Columbia County SWCD		None	Inconvenient to work around	No	No	No	No	
Sauk County		None	Aesthetic intrusion	No	No	No	No	
City of Portage		None	No increased land value	Yes, oppose	No	No	No	
1st Ward Alder.		None	No protection for citizens	No	No	No	No	
Caledonia		None	No effect on Town	DNK	DNK	No	No	
Lewiston		None	Does nothing for the problem	No	No	No	No	
Fort Winnebago		None	None	No	No	No	No	
Pacific		None	Political opposition	No	No	Yes	No	
Faifield		None	Cost more than home	No	No	No	No	
WRFCC		None	Step backwards	NA	NA	No	No	
Citizens for Sensible Zoning		Unnecessary	Too expensive	DNK	DNK	No	No	
Portage Canal Society		None	Won't work at 100%	No	No	No	No	

DNK = Do not know; NA = Not applicable to this organization.

ALTERNATIVE 6
NO ACTION

Organization	Pre. Alt.	Benefits	Shortcomings	Impact to Organ. Workload	Impact to Organ. Budget	Acceptability Public	Acceptability Politic.	Preferred Modifications
HUD								
FEMA		No more investment in the floodplain	Continued probability of disaster	Yes	Yes	Yes	Yes	
Wisconsin DNR		Environmentally best	Appear indifferent; no 100-yr. protect.	Yes	Yes	No	No-local Yes-State	More O & M funds required.
Columbia County	X	Adequate now	None	No	No	Yes	Yes	
Columbia Couty Plan. & Zoning	X	Least costly and disruptive	None	No	No	Yes	Yes	
Columbia County SWCD		Maintians status quo	None	No	No	Maybe	Maybe	
Sauk County		None	None	No	No	Yes	Yes	
City of Portage		No additional work	Zoning stays as is	Yes	Yes	No	No	
1st Ward Alder.		No additional work	Inadequate protection	No	No	No	No	
Caledonia	X	Adequate now	None	No	No	Yes	Yes	
Lewiston			Zoning stays as is; Flood threat remains	No	No	Yes	Yes	
Fort Winnebago				Yes[1]	Yes[1]	Yes	Yes	
Pacific		No additional work	Inadequate protection	No	No	Yes	Yes	
Fairfield	X	Protection adequate	None	No	No	Yes	Yes	
WRFCC		Less cost than others	Orphaned by DNR now	NA	NA	No	No	
Citizens for Sensible Zoning	X	Adequate now	None	No	No	Yes	Yes	
Portage Canal Society		Maintain Status Quo	Cost of the study wasted	No	No	No	No	

DNK = Do not know; NA = Not applicable to this organization

[1] If the DNR does not maintain the levees, the Town anticipates bearing a portion of the cost.

CORRESPONDENCE

The letters provided herein include pertinent correspondence received from or sent to various interests and agencies through distribution of the draft feasibility report and draft environmental impact statement on 15 July 1983. Subsequent letters, including comments on the draft report, are provided in attachment 1 of the main report dated December 1983.

January 31, 1978

3550

Mr. Harold O. Vik
General Engineering Company, Inc.
P.O. Box 340
Portage, Wisconsin 53901

Dear Mr. Vik:

Re: Wisconsin River, Portage, Wisconsin - Feasibility Study for Flood Control

Thank you for your letter regarding the subject flood control study being conducted by the Corps of Engineers. The purpose of that flood control study is to look at various alternative means of structural and non-structural measures for protecting people and property in the Portage and Columbia County area from damages caused by flooding. Following the study an alternative plan will be recommended to Congress, perhaps for implementation, if economically justified.

You asked if this Department is prepared to accept the responsibilities noted in the plan of study prepared by the Corps of Engineers on pages 58 and 59. Specifically they include the responsibilities to:

A. Provide all land essements, right of way, and relocations and all operation and maintenance costs necessary for the project.

B. Hold and save the United States free from damages to the construction, operation and maintenance of the project to the extent authorized by Sections 895.45 and 895.46, Stats., except for damages due to the fault and negligence of the United States or its contractors.

C. Comply with that provision of the uniform relocation of assistance and real properties acquisition policies act of 1970 (PL91-646).

Let me point out that these nonfederal obligations in the State of Wisconsin have been carried forth by the local municipality on all similar flood control projects in the past. The reason is that the State Constitution prohibits this Department or any State agency from participating in projects of internal improvement such as this one where private property would be benefited. As a result, it is my feeling that the letter of intent to carry forth on these nonfederal responsibilities should come from Columbia County and the City of Portage. While this Department strongly supports the project we have little choice regarding our participation in these aspects of the study. We are, as you know, participating in the engineering studies to provide flood flows on the entire Wisconsin River and that information will be supplied to the local municipalities and is being utilized by the Corps of Engineers in this flood control study.

This Department does have some responsibility and obligation in the existing levee system that was charged to us by the Legislature. We will cooperate to the maximum extent allowable in an approval flood control alternative. The Legislature may also wish to provide us or the state with further direction or authority.

Let me suggest that the City of Portage and/or Columbia County may wish to explore the alternatives presently being utilized by the City of Prairie du Chien. In that case, a flood control project that involves relocation of people from the flood plain under a Corps flood control project is being implemented and the local share is being supplied by the City of Prairie du Chien. However, the local share is being provided to the City of Prairie du Chien by a HUD community development grant which will provide that portion of the cost. I would encourage the City of Portage and Columbia County to initiate exploration of possible funding alternatives at the earliest possible date. It is my understanding that the Department of Local Affairs and Development may be able to assist in grant application preparations for such projects.

Please keep me posted on these matters as they go along. I want to again assure you of my personal interest in this project carrying through and resolving some of the problems faced by those persons in the City of Portage and Columbia County area. The interest of the entire citizens committee in putting forth their time and effort, is certainly appreciated.

Sincerely,

Anthony S. Earl
Secretary

cc: Corps of Engineers - St. Paul
USGS
DLAD
Southern District
Mayor - City of Portage
Herb Raether - Chariman Columbia County Board
Senator Bidwell
Representative Thompson
Representative Day

March 17, 1978

State of Wisconsin
Department of Natural Resources
P. O. Box 7921
Madison, Wisconsin 53707

Subject: **Wisconsin River Flood Control Feasibility Study at Portage**
Your Reference: 3550

Attention: Mr. Anthony S. Earl, Secretary

Dear Mr. Earl:

The Wisconsin River Flood Control Citizens' Committee has expressed concern about your letter of January 31, 1978, relative to the Wisconsin River Flood Control project.

You point out on the second page of your letter that the non-federal obligations in the State of Wisconsin have been carried forth by local municipalities on all similar flood control projects in the past. It does not appear to us that there is a comparable project in the State of Wisconsin because, specifically by statute, the Wisconsin River levees are a responsibility of the Department of Natural Resources.

You state that the State Constitution prohibits your department or any state agency from participating in projects of internal improvements such as this one, where private property would be benefited. It appears to us that the precedent has been set for many years. When the State Levee Commission was organized, it was organized under the State Statutes and completely funded by the State of Wisconsin. After the dissolution of the State Levee Commission, the State has continued to fund the operation and maintenance of the Portage Levee System.

We would like a clarification of this issue and we are anxious for action on the responsibility for your enumerated items - A, B and C. We are putting forth considerable effort to have the federal funding for this project reinstated and that procedure becomes somewhat difficult when the issue is apparently being sidestepped by DNR.

Yours truly,

Harold O. Vik, Chairman
Wisconsin River Flood Control
Citizens' Committee

HOV:rh
cc: Senator Bidwell
Representative T. Thompson
Corps of Engineers, % J. Bailen

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Anthony S. Earl
Secretary

BOX 7921
MADISON, WISCONSIN 53707

May 5, 1978

IN REPLY REFER TO.

Mr. Harold O. Vik, Chairman
Wisconsin River Flood Control
Citizens' Committee
P. O. Box 340
Portage, Wisconsin 53901

Re: Wisconsin River Flood Control Feasibility Study

Dear Mr. Vik:

In your letter dated March 17, 1978, you questioned the Department of Natural Resources position that the Wisconsin Constitution prohibits this agency from participating in projects of internal improvements where private property would be benefited. In order to address your concerns a brief historical accounting of the progression of responsibility for the levee system is warranted prior to the analyzing the commingled internal works and ownership issues.

AUTHORITY

Through Chapter 282, Laws of 1901, the Portage Levee Commission was created for custodial purposes. In 1961, this commission was abolished (Chapter 191, Section 108, Laws of 1961) and its duties were reassigned to the Water Regulatory Board. However, the Board was eliminated and the Public Service Commission was vested with the responsibility of maintaining the levee system. Finally, through state government reorganization, the Department of Natural Resources (Horicon Area Supervisor of the Southern District) inherited the mandate of the Portage Levee Commission.

The empowering legislation reflects the same responsibilities as those imposed on the defunct Levee Commission in 1913 (Chapter 751, Laws of 1913) and presently incorporated in section 31.36(4), Wis. Stats. This section recites, "The department shall construct, strengthen and maintain the Portage Levee in such a manner as will best protect the vicinity from the overflow of the Wisconsin River". Since its inception, the Levee Commission had the authority to condemn "lands for right of way, earth material, borrow ("barrow" in 1913) pits, quarry, timber and brush privileges as they may, in their judgment, deem necessary for such purposes". This provision has been retained in section 31.36(2), Wis. Stats. However, it is inapplicable since there are no levee commissioners.

When the commission was abolished "all its functions, assets and liabilities, properties and uncommitted funds" were granted to the Water Regulatory Board, with instructions to the Board to "complete all actions and transactions of the Commission" which were not completed as of June 30, 1961.

The authorization for power of condemnation presently contained in section 31.36(2), Wis. Stats., wasn't modified to grant these powers to the Regulatory Board, its successors and assigns but has remained as a separate section referring to the levee commissioners (Chapter 191, Sections 69, 70, Laws of 1961). This oversight prohibits the Department from consolidating title to those parcels comprising the Portage Levee System. In order to eliminate this ambiguity, the Legislature could recast section 31.36(2), Wis. Stats., to eliminate the reference to "levee commissioner" and substitute the "Department".

INTERNAL IMPROVEMENTS ISSUE

The complexity of the levee problem is enhanced by the issue of constitutionality of the Department's ability to maintain the system in view of Article VIII, Section 10, of the Wisconsin Constitution, which forbids the state to expend monies on internal improvements. The Wisconsin River Levee System falls within the definition of an internal improvement by virtue of The State ex. rel. Jones v. Froelich, 115 Wis. 32 (1902). The court stated that, "In the light of the historical situation surrounding the framing of our constitution, and of the construction, both practical and judicial, since given, we cannot doubt that, prima facie, levees or dikes to restrain the waters of a navigable river are works of internal improvement, within the meaning of the prohibitory section invoked by the attorney general; and that, too, whether the main purpose be promotion of navigability, creation of water power, or reclamation of adjoining lands. In any of these there is enough of pecuniary benefit to warrant belief in the possibility, at least, that they may be undertaken by private enterprise or local associations." Ibid at p. 36.

Furthermore, the court stated "... that the fact that the construction might incidently avert possible peril to life does not make it other than a work of internal improvement; nor is the declaration of such purpose in the title of the act, authorizing such construction, be any more effective to that end." Ibid, p. 41. To substantiate this holding, a latter Attorney General's Opinion (32 Op. Att'y. Gen. 420 (1943)) recited that the State could not build levees, dredge channels or otherwise engage in flood control activities or restore residential properties, business establishments or public utility facilities damaged and destroyed by flood and could not, as incident to flood control, remove buildings to new sites. In essence, though fences serve a public purpose and are within the ordinary police powers conferred by the general vesting of legislative power, they are works of internal improvement and are thereby constitutionally prohibited.

While the state government is subject to constitutional constraints to contract a debt and prohibit the carrying on of works of internal improvement, governmental units created by the State and discharging their public functions in particular localities or geographical subdivision of the State are not so subject, Redevelopment Authority of City of Madison v. Canepa, (1959) 97 N.W. 2d 695, 6 Wis. 2d 643. Thus, counties (Sauk and

Columbia), municipalities, and towns, when properly authorized, may contract public indebtedness pursuant to a work of internal improvement (reconstruction of the levee system). Otherwise, it would be impossible for our cities and villages to improve their harbors; to pave and grade their streets; to build their bridges; or to do many other things calculated to increase their trade and property and promote the comfort and welfare of the citizens, Bushnell v. Beloit, (1860) 10 Wis. 195.

The most serious objection in permitting the affected political subdivisions to reconstruct and maintain the Portage Levee System is the argument that such expenditures aren't for a public purpose. In State ex. rel. W.D.A. v. Dammann, (1938) 228 Wis. 147, the court suggested the following general guidelines for determining whether or not a particular expenditure met the public purpose test:

> "The course or usage of the government, the object for which taxes have been customarily and by long course of legislation levied, and the objects and purposes which have been considered necessary for the support and proper use of the government are all material considerations as well as the rule that to sustain a public purpose the advantage to the public must be direct and not merely indirect or remote. Ibid, p. 180.

A public project is not a work of internal improvement just because it creates a private benefit. The question is whether it is the function which is predominately governmental in character or one which is better performed by private parties.

The Wisconsin Supreme Court in State ex. rel. Jones v. Froehlich, supra, intimated that there may be a public purpose in the construction of the proposed levee. Furthermore this court cited Bushnell v. Beloit, supra, which held that "such works (railroads, canals, streets, railway (levees?)) serve a public purpose and are within the ordinary police powers conferred by the general vesting of legislative power, that it has been held that the legislature may delegate to counties and municipalities authority to aid them by loans of credit". p. 41

In summary, it is arguable that though the state would be precluded from expending public funds to reconstruct or repair the levee system by virtue of Article VIII, Section 10, of the Wisconsin Constitution, political subdivisions are not so prohibited. Since reparation of the levee constitutes a legitimate exercise of the State's police powers, albeit constitutionally barred, such authority is delegable to the affected political subdivision.

Article VIII, Section 10, of the Wisconsin Constitution, as amended, contains several exceptions to the general prohibition against works of internal improvement. One of these exceptions is the following:

> "... whenever grants of land or other property shall have been made to the State, especially dedicated by the grant to particular works of internal improvement, the State may carry on such particular works and shall devote thereto the avails of such grants, and may pledge or appropriate the revenues derived from such works in aid of their completion ..."

The constitution appears to authorize the State to "carry on" works of internal improvement provided (1) the property has been obtained by grant and (2) that no State debt is incurred in implementing the improvements. Since the Department of Natural Resources could acquire control of the levee system by a series of grants from federal and local governments and individual landowners, then the first phase of this exception has been satisfied.

The more relevant issue is whether or not the expenditure of funds for reconstruction of the levee system would result in a State indebtedness. The general rule is that neither the State nor its municipalities incur debt for constitutional purposes when they incur liabilities for current operations which are within budgeted revenues, State ex. rel. Thompson v. Giessel, (1953) 267 Wis. 331. If the funds for repair and maintenance of the levee system would come from current appropriations by the legislature then no State future debt is contracted. The constitutional authority delegated to the State to "carry on" works of internal improvement given to it by grant must include the authority to make repairs necessary to maintain and "carry on" such works in concert with the requisite appropriations to pay such repairs.

The constitutionality of authorizing expenditures for the repair and maintenance of the Portage Levee System is questionable. There is no doubt that the State can repair those portions of the embankment within the Pine Island Wildlife Area and the Highway 51 right-of-way. However, the State's ability to provide future reparation for the balance of the levee is shrouded by the holding in State ex. rel. Jones v. Froehlich, and the prohibitions of Article VIII, Section 10, of the Wisconsin Constitution.

OWNERSHIP

Perhaps the most bizarre problem associated with the Wisconsin River Levee System is the ownership question. The State owns some portions; presumably that section of the Highway 51 embankment and all portions within the Pine Island Wildlife Area. The City of Portage acquired title to some parcels pursuant to authorization from Chapter 322, Laws of 1883, and subsequently conveyed by the City to the U.S. to construct a levee. In 1916, the federal government decided to abandon the project. As a result, the Secretary of War was empowered to quitclaim the "government levee" and the right-of-way to either the State or the City of Portage whenever one "should satisfy the Secretary of War that they are empowered to accept same". (U.S. Statutes at Large 39:401 (1916)). However, there is no evidence of the State's acceptance of this deed, and we have no indication of the City's acceptance in our records.

During the initial phase of construction, affected municipalities assumed the developmental responsibilities. They were authorized to condemn lands for the purposes (Chapter 213, Laws of 1873). This legislation was amended by Laws of 1876, p. 589 to allow an adjacent landowner to build his own piece of the levee with reimbursement from the municipality. Consequently, some individual landowners possess a fee interest to that land underlying the levee. In all other cases, the municipalities of

Portage, Caledonia, Fairfield and Pacific, the State of Wisconsin (through the DNR and DOT), and the federal government are the owners of interest to the embankment. Finally, several property owners granted municipalities easements to build the levee, rather than sell the land outright.

In summary, the constitutional and ownership problems directly affect the Department's responsibility for repair and maintenance of the levee system. The Department is not attempting to shirk its responsibilities but we are attempting to live under our constitutional constraints.

Sincerely,

Anthony S. Earl
Secretary

~~cc:~~ Corps of Engineers - St. Paul
USGS
DLAD
Southern District
Mayor, City of Portage
Herb Raether - Chairman, Columbia County Board
Senator Bidwell
Representative Thompson
Representative Day
Floyd Stautz - 4

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCE

Anth

MADISON, WISCO

IN REPLY REFER TO: 3

April 17, 1980

Mr. John Bailen
St. Paul Dist. Corps of Engineers
1135 U.S. Post Office & Custom
House
St. Paul, MN 55101

Dear Mr. Bailen:

Re: Portage Levee History

As you requested, please find a copy of a Department of Natural Resources document which summarizes the construction history of the Portage Levee System.

If I can be of any further service, feel free to contact me.

Sincerely,
Bureau of Water Regulation & Zoning

Kenneth G. Johnson

Kenneth G. Johnson
Environmental Engineer
Water Regulation Section

KJ/mg

Enc.

NATURAL RESOURCES DEPARTMENT

INTRA-DEPARTMENT ORGANIZATION CONFERENCE

Division of Resource Development - Engineering Service

Introduction:

Although the large majority of technical personnel of the Division of Resource Development consists of engineers, a very small amount of activity is devoted to providing engineering services to the Division. This is because the mission of the Division is regulatory and hence, the Division does not maintain any extensive facilities or structures in serving the public. The one activity that can be categorized as "engineering services" was transferred to the Division from the Public Service Commission under the provisions of Chapter 614 of the Laws of 1965, The Water Resources Act. The transfer became effective July 1, 1967.

Mr. H. V. Tennant became secretary and engineer for the Portage Levee Commission sometime around 1921 and continued in that capacity until 1965. During that time the levees were considerably raised and strengthened. It has been reported that only one break in the levees occurred during Mr. Tennant's tenure of office.

In 1938, the largest flood of record at Portage occurred on September 1st and 2nd. Apparently, the water came within inches of overtopping the levees at several places. After this occurrence, the levees were raised approximately 2 feet above that water surface at all points.

The dams in the central part of the state were constructed in the latter part of the 1930's under the direction of Mr. Tennant, who was the State Hydraulic Engineer at that time. In 1937, the Water Regulatory Board was created by Chapter 379, Laws of 1937. Mr. Tennant was employed as Engineer and Secretary by the Board, so the Portage Levee Commission and the Water Regulatory Board became tied together through him. Then in 1961, the Portage Levee Commission was abolished and its duties were added to those of the Water Regulatory Board, which was phased out in 1965. These duties were then transferred to the Public Service Commission and on to this Division.

GPW/jj

The foreman at Babcock also supervises the daily operations on the Wisconsin River levees at Portage. These levees consist almost 17 miles of sand dikes stretching about 12 miles along the river on both the east and west banks. They prevent flooding in the city of Portage, the surrounding farm land, and the nearby Fox River.

Operations at Portage are conducted from a small garage which houses the tractor and two trucks used for normal maintenance. Work begins with the spring thaw every year. About 2 years out of 3, it starts with flood operations. As soon as the ground thaws, it is necessary to patrol the levees to get rid of burrowing animals and fill their holes. Later it is necessary to cut the brush and spray the weeds, mow the levees and perform the numerous other odd jobs necessary to keep the levees open for inspection and accessible for flood operations. In the fall, it is again necessary to patrol the levees for burrowing animals until the ground is frozen solid, so there will be no holes to endanger the levees when the spring flood comes.

At times, it is necessary to undertake larger projects to protect the levees from erosion and collapse. Riprapping with large boulders has proved to be the most effective means of protecting the levees from the swift current. In the past, the Columbia County Highway Department has done all the heavy construction work at cost, and they have expressed their willingness to continue to cooperate in this

manner in the future. Columbia County has also provided the men and equipment necessary to patrol and protect the levees in times of extreme floods.

The nature of the work required during flood emergencies is dependent on the height of the flood. If the water level is only expected to reach about halfway up the levees, it is only necessary to patrol the levees during the daytime to insure no burrowing animals make holes through the levees and slow boils do not develop. If higher floods are anticipated, it may be necessary to patrol the levees day and night with Division personnel. Floods which approach the top of the levees require constant watching day and night over the entire length of the levee. Because some reaches become inaccessible by automobile and there is no road at the top of the levees, men from Columbia County are used to help Division personnel patrol the levee on foot. These men are equipped by the county with walkie-talkies to provide communication.

The levees have served their purpose well for the past 30 or 40 years, but they are not built to the best standards. They were not designed and built at one time as is the case with some flood control projects. Instead, they grew haphazardly over a period of 110 years as money became available or the river threatened to break a section.

The first statutory authority for the levees is contained in Chapter 159, Laws of 1854, which authorizes the Fort Winnebago and

Duck Creek Plank Road Company to construct and maintain a levee from their plank road to the Wisconsin River at or near the south line of the town plat of Portage to protect the plank road. In Chapter 213, Laws of 1873, the Legislature gave the cities and towns in the area authority to construct and maintain a levee along the southerly bank of the Wisconsin River and authorized these municipalities to appropriate and expend money for such purpose. In 1889, the Legislature gave the consent of the state to the U. S. Government to construct and maintain a levee from the Portage Canal to such point in the town of Pacific as it deems necessary and gave the city and town officials authority to acquire the title to whatever lands were needed for the right-of-way. Chapter 282, Laws of 1901, established the Portage Levee Commission to supervise the spending of $20,000 appropriated from the general fund to construct and strengthen the existing levee system at Portage. Successive sessions of the Legislature appropriated more money and continued the commissioners in office, eventually making the Portage Levee Commission a permanent commission. In 1905, the justification for the expenditure of state funds on the levees first appeared. The preamble of the law states that it was apparent that the drainage fund, set up by funds from the sale of swamplands according to an 1850 act of Congress, had contributed more money to the general fund than was withdrawn for the purposes for which it was established. So it was reasoned that this excess money could be withdrawn at that time.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

December 23, 1980

IN REPLY REFER TO: 1520

YOUR FILE: NCSED-ER

Mr. Robert E. Post
Chief, Environmental Resources Branch
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Mr. Post:

The following Wisconsin endangered and threatened species have been recorded as of this date in the Portage, Wisconsin, flood control study area as described in your letter to me of November 14, 1980:

Western Ribbon Snake (endangered) - "Between Portage and Wisconsin Dells".
Speckled Chub (threatened) - Wisconsin River near Portage.
Carex lupuliformis (endangered) - collected in NE SW 19-12N-9E.
White Lady's Slipper, Cypripedium candidum (threatened) - Swan Lake area.
Prairie Parsley, Polytaenia nuttallii (threatened) - collected in 1927 "opposite Portage".

In addition, on the basis of the presence of both upland and river-bottom hardwood forest types in the study area, you could expect to encounter two threatened hawk species, Cooper's and Red-shouldered.

Bald Eagles and Ospreys (both endangered) are found in the Castle Rock and Petenwell Reservoir areas. Eagles are present primarily as wintering residents below the dams, while there are Osprey nests on both flowages.

Sincerely,
Office of Endangered and Nongame Species

James B Hale

James B. Hale
Director

JBH:mg

cc: L. Posekany - EI/3

wisconsin river power company

January 14, 1981

Mr. Louis Kowalski
Engineering Division
Department of the Army
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Mr. Kowalski:

I am replying to your letter of December 31, 1980 in which you ask for elevation storage curves for Du Bay, Petenwell, and Castle Rock. You also pose two questions which relate to a flood control method for Portage, Wisconsin, namely:

1. What would be the effect of lowering the operating ponds at Du Bay, Petenwell, and Castle Rock five feet - ten feet?

2. What would be the effect of raising the dams and associated works at Du Bay, Petenwell, and Castle Rock five feet - ten feet?

As to the curves, I am supplying you with curves for Petenwell and Castle Rock. An elevation storage curve was never developed for Du Bay. I do have a calculation of the storage in the top five to six feet of each of the reservoir dams which I assume would be helpful.

As to the two questions, it is most difficult to give rational answers to such radical and/or absurd suggestions, but I will try.

Let's take No. 2 first. Because of the many areas of low or flat ground surrounding all three flowages, it would be most impractical to store an additional five to ten feet of water behind the dam as a great deal of land would be inundated and damaged. Secondly, our earth dike systems are extensive at all three locations. Between the three, we are talking about 15 miles of earthen dike that would have to be rebuilt and raised which would be a monumental task. Likewise, all gate piers and gates would have to be increased in height substantially; between the three, we are talking about 45 large taintor or flood gates. The powerhouse walls would have to be reconstructed so as to make them waterproof. From my 30 years of experience with these projects, I would conclude that we are presently at the practical maximum limit of operation at all three locations. To raise these dams another five to ten feet would be a physical and economical impossibility.

As to No. 1, I suggest you obtain the November, 1980 USGS publication entitled "Streamflow Model of Wisconsin River for Estimating Flood Frequency and Volume." In it they refer to what the existence of the reservoir system has done and theoretically will do for peak shaving of large floods. We believe that we practice about as much flood control as is possible and we also believe that once we hit a flood flow of about 70,000 cfs as measured at Wisconsin Rapids that the reservoir system and other dams have minimal effect on flood control. We presently follow the practice of drawing these three ponds down about five feet each winter (depending on the water content in the snow covering the upper Wisconsin River Valley). I believe you suggest that we keep the ponds drawn down this five feet all during the spring, summer, and fall seasons in anticipation of a flood. This would quite drastically affect our peak generating capacity and would also negate any recreational value that these impoundments now have (which is considerable). By going down ten feet, you would more than double the problems associated with generation and recreation.

It is my honest opinion that none of the four suggestions or alternatives in your two questions are even worth considering as they are impractical, uneconomical, and would present many more problems than they could possibly solve.

During any flood flows at Wisconsin Rapids which appear to be exceeding about 40,000 cfs, we will work very closely with Wisconsin Valley Improvement Company to minimize the peaking effect at Portage, Wisconsin. For the past five years or more, WVIC has had ongoing communications with the Minneapolis Weather Bureau and I believe the Corps in passing along river flow information as it relates to Portage. We have during the past major floods artificially increased the flow out of Castle Rock many, many hours in advance of the peak reaching Castle Rock so as to be prepared to exercise peak shaving as the high flows reach this point. This practice has seemed to work fine and we have been successful in reducing the outflow peak by as much as 10,000 to 15,000 cfs. However, there is no real assurance that this could be accomplished during every flood as it all depends on the duration of the peak flow. We might add at this point that some of the local politicians have criticized this type of manipulation and at times we have difficulty in convincing them that this type of operation benefits all concerned. We would be glad to discuss or review our flood type operation policies with anyone knowledgeable with river flows. It is our opinion that we are constantly aware of flooding problems at many points on the river, including Portage, and exercise as much helpful control as is possible within the practical and sensible limits of our operation. We do have very strict elevation levels within which we must operate; these have been set by the DNR. It is our opinion that during a very major flood we would for a short time exceed some of the maximum elevations at these three dams if, in fact, the conditions and time elements dictated that we could minimize some serious flooding downstream; however, to date we have not done this at either Petenwell or Castle Rock. When I say exceed the limits, I am suggesting an increment of six to nine inches.

January 14, 1981

Mr. Louis Kowalski
Page 3.

In summary, I would conclude that the proposals that have been suggested in your two questions are neither practical or sensible.

Yours very truly,

WISCONSIN RIVER POWER COMPANY

Max O. Andrae

Max O. Andrae
President

CC: D.P. Meyer
Louis Pilsner - Power Supt., CWPCo.
R.C. Wylie - WVIC

United States Department of the Interior

FISH AND WILDLIFE SERVICE

GREEN BAY FIELD OFFICE (ES)

Univ. of Wisconsin—Green Bay
Green Bay, Wisconsin 54302

IN REPLY REFER TO
GBFO

January 16, 1981

Colonel William W. Badger
District Engineer
U.S. Army Corps of Engineers
St. Paul
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This provides the U.S. Fish and Wildlife Service's Stage 2 planning aid report to accompany your Feasibility Study of alternatives for the Portage Flood Control Project, Columbia County, Wisconsin. As part of the scope of work for Fiscal Year 81, we are providing an analysis of the impacts to fish and wildlife resources of a range of structural and non-structural alternatives being considered to control flooding of the Wisconsin River in the Portage area. Our analysis is based on the flood control alternative information presented in Chapter 5 of the Wisconsin River at Portage Feasibility Study Hydrology and Hydraulics Appendix, dated July 30, 1980. Accordingly, we were as specific as possible based on the information given.

These comments are of a preliminary nature and are submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). They are also consistent with the National Environmental Policy Act of 1969 and Presidential Executive Orders 11988 and 11990 on Floodplain Management and Protection of Wetlands.

STUDY AREA

The main study area is the Wisconsin River floodplain from the Columbia-Sauk County line near the Village of Lewiston, downstream through Portage to the Interstate 90-94 bridge. Also included are portions of Duck Creek and the Baraboo River as affected by Wisconsin River backwater (for approximately 8 miles above the mouth of each), and the Fox River basin as affected by Wisconsin River overflows. The municipalities within the study area generally include the City of Portage and the Townships of Lewiston, Caledonia, Pacific, and Fort Winnebago in Columbia County and the Township of Fairfield in Sauk County (Figure 1). Please reference our February 1, 1980, Stage 1 report for a detailed description of the fish and wildlife resources of the study area.

FISH & WILDLIFE HABITAT - WITHOUT THE PROJECT

Using topographic maps and an aerial photographic mosaic (4 inches to 1 mile), we delineated the primary wetland and upland habitat types occurring in the study area (Figure 2). In November, 1980, we ground truthed and characterized each type to the extent that access would allow. The major habitat types and their associated wildlife species that could be affected by the project are described below. The predominate wetland types are further classified in Table 1.

1. Palustrine Forested Wetland [1/] - bottomland floodplain woods occurring mainly along the Wisconsin and Baraboo Rivers. Prevelent vegetation comprising this habitat type are swamp white oak, silver maple, black willow, river birch, cottonwood, American elm, box elder, and black, green, and white ash. The understory is dominated by a diverse sedge (*Carex sp.*) community. Wildlife known to inhabit or use the floodplain woods at Portage include white-tailed deer, ruffed grouse, woodcock, red-shouldered hawk, osprey, barred owl, numerous songbirds (e.g., red-headed woodpecker, bluejay, kingfisher), raccoon, red and gray squirrel, cottontail, beaver, and river otter.

2. Palustrine Scrub-Shrub Wetland - much of the wetlands adjacent to the Fox River to the north and east of Portage are shrub wetlands. Typical vegetation composing the community are silver maple, red-osier dogwood, cottonwood, tag alder, willow (*Salix sp.*), bluejoint grass, sedges, cattail (*Typha sp.*), and reed canarygrass. The associated wildlife community includes white-tailed deer, woodcock, ruffed grouse, ring-necked pheasant (winter cover), raptors (e.g., red-tailed hawk), cottontail, and several species of small mammals, reptiles, and amphibians.

3. Palustrine Emergent Wetland - a wetland type that is especially abundant along Duck Creek, but is also numerous in the ponds, potholes, and old river oxbows of the study area. The vegetative community includes river bulrush, spikerush (*Eleocharis sp.*), bluejoint, arrowhead (*Sagittaria sp.*), water plantain, phragmites, sedge, and cattail. These wetlands provide excellent waterfowl (e.g., Canada geese, mallard, blue-winged teal) breeding and feeding habitat as well as prime habitat for wading water birds (e.g., great blue and green herons, great egret, American bittern, greater sandhill crane), and furbearers (e.g., muskrat,mink, otter). Emergent wetlands also provide spawning and nursery habitat for fish such as northern pike, perch, and largemouth bass.

[1/] Classification of Wetlands and Deepwater Habitats of the United States. USDI, Fish & Wildlife Service. December, 1979.

Table 1. Classification of the Major Wetland Types in the Portage Study Area

Type	System	Class	Subclass	Water Regime	Dominance Type	Subordinate Types	Primary Location
7	Palustrine	forested wetland	broad-leaved deciduous	semipermanently flooded	swamp-white oak	river birch, ash, silver maple	Wisconsin and Baraboo River floodplains
6	Palustrine	scrub-shrub wetland	broad-leaved deciduous	seasonally flooded or saturated	tag alder	silver maple, red-osier dogwood, willow, reed canarygrass	Fox River floodplain and the Big Slough area
3-5	Palustrine	emergent wetland	persistent	semipermanently flooded	sedges	cattail, river bullrush, blue-joint, phragmites, spikerush	Duck Creek, Long Lake area, the oxbows of the Baraboo and Wisconsin Rivers and most wetlands between STH 51 and the Wisconsin River flood plain forest
	Lacustrine	unconsol-idated bottom	mud or organic	permanently flooded	*	*	Long, Silver, and Swan Lakes and Lake George
	Riverine	unconsol-idated bottom	sand or mud	permanently flooded (perennial streams)	Diptera	Amphipoda, Gastropoda	Fox River
					Diptera	Trichoptera, Gastropoda	Wisconsin River
					*	*	Baraboo River, Duck and Neenah Creeks

Note – Classification based on USFWS Wetlands of the United States, Circular 39 and Classification of Wetlands and Deepwater Habitats of the United States

* Dominant and subordinate Orders of macroinvertebrate species unknown

4. Old Field - This type of habitat is especially evident on the Pine Island State Wildlife Area (PISWA) on the south side of the Wisconsin River, just west of State Highway 78. Prairie grass fields are used by ring-necked pheasants, quail, gray partridge, mourning dove, meadowlark, badger, several species of small mammals, and raptors which prey on the small mammals.

5. Oak Forest - Farther west but in the same area of the PISWA, the Old Field habitat grades to Oak Forest. White oaks, river and paper birch are typical along with cedar, sumac, pine plantings, and tag alder shrubs. Ruffed grouse, white-tailed deer, red and gray squirrels and cottontails are some wildlife species that use these forests.

6. Cropland - Corn and alfalfa are the principal crops grown. Ring-necked pheasants, quail and gray partridge are common near intensively cultivated farmlands where shrubs and brushy fence rows are near.

7. Lacustrine Wetland - includes those water bodies such as lakes and ponds greater than 20 acres. Long Lake, Silver Lake, Lake George, and Swan Lake are examples of Lacustrine Wetlands in the study area.

8. Riverine Wetland - includes those wetlands and deepwater habitats within a channel, and are usually flowing water systems. The Wisconsin, Baraboo, Fox Rivers and Neenah and Duck Creeks are Riverine Wetlands in the study area.

Our Stage 1 report described the fish and other aquatic life that inhabit the lakes, rivers, and creeks of the Portage area.

PLANS OF DEVELOPMENT AND IMPACTS - WITH THE PROJECT

I. CHANNEL DIVERSIONS TO BY-PASS PORTAGE

Three diversion channel alternatives are proposed to by-pass floodwater from the Wisconsin River around the City of Portage: a) through Long Lake, b) to the Baraboo River, and c) to the Fox River via Big Slough and Neenah Creek (Figure 3). Two flow conditions for each alternative are presented: The 100-year flood (100 YF) which results in approximately 25,000 cfs spillage, and the Standard Project Flood (SPF) which results in 80,000 cfs spillage. The channel design characteristics proposed to convey water for each flood condition by alternative are listed in Table 2.

The diversion channels would cause several similar environmental consequences.

1. Direct loss of fish and wildlife habitat. The approximate acreages of each habitat that would be directly eliminated between the prospective river basins if connected by a diversion channel are listed in Table 2 for the 100 YF and SPF. The main habitats affected would be Palustrine Forested Wetlands (PFW), P. Emergent Wetlands (PEW), P. Scrub-Shrub Wetlands (PSSW), Croplands (CL), Lacustrine Wetlands (LW), Old Field (OF),

Table 2. Proposed diversion channel designs and acres of each habitat type that would be directly eliminated if constructed.

100 Year Flood

	Length (ft.)	Bottom Width (ft.)	Top Width (ft.)	Depth (ft.)	Habitat Type (Acres) PFW	PSSW	PEW	CL	LW	OF	OKF	C	Total Acreage
Long Lake	25,000 4.7 mi.	200	213	20	69				20	17	16		122
Baraboo River	6,000 1.1 mi.	330	339	13	6		2			12	27		47
Fox River (via Big Slough and Neenah Cr.)	20,000	1,000	1,010	15	159	49		137			48	71	464

Standard Project Flood

	Length (ft.)	Bottom Width (ft.)	Top Width (ft.)	Depth (ft.)	Habitat Type (Acres) PFW	PEW	PSSW	LW	OKF	CL	OF	C	Total Area
Long Lake	25,000 4.7 mi.	650	663	20	169			81	66		65		381
Baraboo River	6,000 1.1 mi.	1,000	1,009	13	20	6			80		34		14[illegible]
Fox River (via Big Slough and Neenah Cr.)	20,000 3.8 mi.	2,200	2,210	15	349		107		107		[illegible]96	156	[illegible],01[illegible]

Legend

PFW - Palustrine Forested Wetlands
PEW - P. Emergent Wetlands
PSSW - P. Scrub-Shrub Wetlands
LW - Lacustrine Wetlands
OF - Old Field
OKF - Oak Forest
CL - Cropland
C - Drainage Canal

and Oak Forest (OKF). The OF and OKF habitats often grade from one to another and also, both contain pockets of wet marsh meadow.

As shown on Figure 3, the channels would cut through several oxbow ponds and pothole depressions in the Baraboo River and Big Slough area. Further, it appears from the conceptual drawing that Long Lake would be almost completely obliterated. These shallow, open water, emergent marsh areas (PEW and LW) are excellent wildlife habitat, especially for furbearers, waterfowl, and shore and wading birds. Serious and irreparable damage would occur if a channel were excavated through this habitat. Fish and wildlife populations would suffer if floodplain trees and understory vegetation were cleared, oxbow ponds cut off and drained, and bank vegetation removed. Big Slough is a shallow 50-acre slough lake about 5 feet deep and contains an emergent and scrub-shrub wetland perimeter. Fish species reported to move in from Neenah Creek include northern pike, walleye, largemouth bass, bluegill, and black crappie. The emergent vegetation around the perimeter provides excellent northern pike spawning habitat when flooded in the spring. The area of Big Slough where the proposed diversion channel would enter is a designated game farm licensed by the Wisconsin Department of Natural Resources (WDNR). Long Lake is a 65-acre oxbow lake about 20 feet deep. Its wetland characteristics and fishery are nearly the same as Big Slough except that the shoreline perimeter contains more scrub-shrub and forested wetlands than emergent wetlands. Both water bodies are also excellent areas for waterfowl and shorebirds.

The magnitude of habitat losses is placed even more in perspective when the hydraulic nature of the channel is considered. Since the channel design depth would approximate low flow conditions for the rivers being connected, it is likely that the hydraulic gradient would effectively drain wetlands along the length of the diversion channel. Therefore, several hundred more acres of PEW, PFW, PSSW, and LW could be drained if a diversion channel alternative were developed.

2. Interruption of wildlife movements. Another concern with long steep sloped channels is that they could interfere with local wildlife movements or trap wildlife within. For instance, in the West several cases have been reported of deer drowning in water conveyance canals or dying from stress and fatigue. The side slopes may become lined with algae and be too slippery to ascend. Impassable fencing and sod-covered cross points have helped to mitigate wildlife mortality and reduce impedance to movements. In the Portage area, white-tailed deer would perhaps be the greatest species of concern in this impact category.

3. Sedimentation. Habitat losses from sediment could result from a diversion channel both in the short term during construction and over the long term from sediment translocation from the Wisconsin River basin. Sediment would build up in the diversion channel and also be flushed into the receiving river or slough. Wetlands and open water habitat would be filled and their use to fish for spawning and nursery activities or their

use to waterbirds for nesting, resting, and feeding would be lost or degraded. The slack pools in the Big Slough area would be especially susceptable to being filled.

4. Impact on Environmentally Sensitive Areas.

a. Pine Island State Wildlife Area. The Long Lake and Baraboo River channels would transverse portions of the PISWA. Concurrence from the WDNR is, of course, a paramount issue. In our opinion, this would be an undesirable and incompatible use of a public recreation area. Game habitat would be degraded, game management would be impaired or complicated and hunting or other recreational use of the area would be interrupted. Note that this area is not strictly a wildlife area, rather it is classified as "multi-recreational use."

b. Baraboo River Floodplain Forest (T12N, R9E, Section 20, 21, 28 and 29). Five hundred and twenty acres of privately owned floodplain forest near the confluence of the Baraboo and Wisconsin Rivers, Caledonia Township, are classified by the WDNR as a Natural Area of Statewide Significance. Red-shouldered hawks (*Buteo lineatus*), a State Threatened species, nest there. The Long Lake channel would almost completely bisect this natural area and destroy prime red-shouldered hawk nesting forest.

c. Greater Sandhill Crane Nesting Habitat. Our bird survey information indicates that several breeding pairs of greater sandhill crane nest in Caledonia and Lewiston Townships, some of which are in close proximity to the proposed diversion channels. Greater sandhill cranes are an important migratory wading bird that was on the Federal List of Rare and Endangered Species. Although it was removed from the list in 1973, marsh grass meadows play an important role in the continued recovery and stabilization of the population. Direct elimination of habitat by channel construction coupled with the potential for wetland drainage along the length of the channel would eliminate or degrade important sandhill crane nesting habitat and force some breeding pairs out. Wetland drainage is one of the biggest threats to the sandhill cranes in Wisconsin.

II. CHANNEL MODIFICATIONS

a. Caledonia Levee Outlet. Another proposed solution to eliminate overflow into Lewiston and Pacific Townships is to construct a 500 foot long outlet in the Caledonia Levee on the south side of the Wisconsin River, about .75 miles west of STH 78 (Figure 3). The PISWA would serve as a lateral reservoir (Caledonia Reservoir) to accommodate the excess 25,000 cfs for the 100 YF and 80,000 cfs for the SPF. However, as stated on Page 5-3, this alternative is not hydraulically feasible without increasing the floodwater storage capability of the PISWA. Levees would have to be constructed around the PISWA at a height adequate to contain a 7-foot depth for the 100 YF and a 10-foot depth for the SPF.

Again concurrence with the WDNR would be one of the first issues to resolve because such a measure may not be compatible with their wildlife management or other recreational objectives. From an environmental point of view, the idea may have merit. The PISWA behind (south) of the Caledonia Levee is primarily upland habitat and at present is protected from most high water conditions of the Wisconsin River. To breach the levee where proposed would cause mainly Old Field and Oak Forest to be flooded. To predict with any certainty the site specific impacts would require that the frequency, depth and duration of inundation be known and also the plant species tolerance to inundation and water level changes. However, it seems fair to surmise that if the area flooded only occasionally, in other words, not every year, the vegetative community could likely tolerate the temporary change. If this were the case, the environmental impacts should be minor, and mostly temporary. The levees could be routed around wetlands as much as possible to further reduce adverse impacts. Some type of outlet structure in the levee would probably be needed to control water entry into the PISWA.

b. Clearing and Snagging. The extensive clearing of approximately 8 miles of the Wisconsin River channel and overbank areas of debris, brush, and trees is a channel modification alternative proposed to increase the river's capacity to convey water and decrease local flooding (Figure 3). A large scale clearing and snagging operation would be highly destructive to the flora and fauna of the river. Many of the effects are obvious, while others are more subtle. From a wildlife viewpoint, bottomland floodplain forests are a highly valuable habitat type due to their capability to support a rich diversity of wildlife species. As shown in the previous description of this habitat type, many popular animals sought after by hunters or otherwise wildlife orientated enthusiasts are found there. Other animals not so popular still perform an important role in the balance of the wildlife community. An extensive clearing project would eliminate hundreds of acres of prime floodplain forest (PFW) and the associated wildlife community. Because bottomlands are being cleared at an alarming rate throughout the country, the Service classifies their loss as a nationally Important Resource Problem (IRP).

Snagging and clearing in and along the river would also have significant adverse aquatic impacts, beginning low in the trophic structure. For example, clearing many broad-leaved trees would reduce the input of leaves and other organic detritus into the water. Several aquatic macroinvertebrates, such as certain species of caddis, crane, and stone fly larvae, ingest and breakdown the coarse particulate organic matter for food. Also, these creatures depend on log jams and brushpiles for stable substrate to inhabit rather than the unstable shifting sandy river bottom. Eliminating the macroinvertebrates' food and substrate over several miles of river would reduce the local population. Further, most river fish use invertebrates as a food source and would then no longer have that option readily available. We recognize, however, that some organisms would be replaced by invertebrate drift. From another perspective, it is well known that many fish such as largemouth bass, walleye, crappie, and catfish

congregate near the cover, food, and shelter from the current that stumpfields and brushfields provide. Accordingly, removing this habitat would have serious irreparable adverse fishery impacts.

c. Dredging. Two dredging schemes are proposed: Construct a trapezoidal channel (3:1 slopes, bottom width of 1,500 ft.) for approximately 8 miles within the Wisconsin River channel from points A to B, or widen and deepen the river between points A and B (Figure 3). Both plans have several adverse environmental effects in common, the most obvious being the conversion by channelization, of a natural river to an artificial water conveyance facility. The destructive biological effects of channelization are well documented in the literature and we do not believe a thorough dissertation on the subject is warranted in this report. We will, however, list the major categories of impacts as they pertain to the fish and wildlife habitat types characteristic of the Portage area.

1. River meanders would be made more uniform and most aquatic habitat diversity such as deep holes, brushpiles, stumpfields, aquatic plant beds, and shallow bays would be eliminated. Habitat diversity functionally and spacially separate groups of fishes and other aquatic life. To eliminate these "nitches" would result in reduced species diversity and bring about a more monotypic community, a typical undesirable effect of channelization.

2. Dredging to widen and deepen the river would likely adversely effect the speckled chub (Hybopsis aestivalis), a State Threatened species. Becker and Myrah (1969) collected this fish approximately .5 mile downstream from the STH 78 bridge. This species primarily inhabits large rivers and mainly in fast water over broad shallow sandy riffles. Another State Threatened fish species that would likely suffer is the black buffalo (Ictiobus niger). It has been reported in the study area but mainly occurs downstream of Portage in the Lake Wisconsin area. The species inhabits sloughs, backwaters and impoundments and is also found in strong currents where the channel narrows.

3. Timbered islands would have to be cleared and a channel dredged through them. Also, several unvegetated sand and mud flats would be removed. Excellent resting habitat for waterfowl, wading waterbirds, and shorebirds would be eliminated.

4. The floodplain could change drastically if the river bed was lowered to contain both normal and flood flows. For example, the abundant floodplain forests (PFW) which now line the Wisconsin River at Portage would no longer get a frequent surge of water and nutrients that floods provide to floodplains. To curtail spillage would make the forests drier and eventually a vegetative change accompanied by a shift in the associated wildlife community could occur. Of equal concern is the significant secondary impacts that could result. If the threat of flooding were removed, floodplain development regulations could change and the bottomlands would become susceptible to clearing for development.

We realize that this would not likely happen on the public lands in the study area, but hundreds of acres of private bottomland would still be in jeopardy. In our opinion, to select a plan that would allow this would be in direct conflict with Executive Orders 11988 on Floodplain Management and 11990 Protection of Wetlands.

5. Approximately 1.9×10^6 cubic yards of sediment would have to be removed to lower the riverbed about 2 feet. Finding environmentally acceptable disposal sites to accommodate the large volume of material could be a serious problem. Our policy on disposal is in an upland site out of the 100-year floodplain and exclusive of wetlands, and other sensitive wildlife habitat. The material would, however, contain a lot of sand which could possibly be stockpiled and used for a beneficial purpose such as sand for roads or fill at building sites. Another problem is that frequent maintenance dredging would have to be conducted to keep the channel functional. The disposal problem would be reoccurring. Also, frequent dredging would roil the bottom and greatly hamper a biological community from becoming stabilized.

III. LEVEE IMPROVEMENT

Several miles of levees have been built along the Wisconsin River in the Portage Area since the late 1800s (Figures 1 and 3). The Portage Levee extends through the city and to the southeast, the Lewiston Levee runs west of the city along the left bank and the Caledonia Levee runs east-west on the south side of the river. Undoubtedly, the environmental characteristics of the floodplain have been profoundly affected by the levees. One obvious change is that the lowland between the levees and the river have remained almost completely undeveloped while development has proceeded on the other levee side where some measure of flood protection was present.

The floodplain forests and other wetlands between the Wisconsin River and levees are prime fish and wildlife habitat. The resource values have been previously discussed and accordingly, the primary environmental objective of any levee system proposed should be to minimize to the greatest extent possible damage to the Wisconsin River and its associated floodplain environment. Three levee improvement plans being considered are shown below.

	100 YF		SPF	
	Length (ft)	Height (ft)	Length (ft)	Height (ft)
a. Portage	21,000 (4 mi.)	6	21,000	8
b. Left bank only	58,000 (11 mi.)	6	58,000	8
c. All	115,000 (22 mi.)	6	115,000	8

We understand that new levees could not be built on the existing ones because they do not meet the Corps of Engineer's design standards. Accordingly, either the existing levees would have to be removed or a new alignment selected, both of which would result in more environmental disturbance than adding to the existing ones. As far as we know, the exact alignments for the three above levee options have not been proposed. In any plan, the positioning of the levees would be critical to preserving floodplain forest and other wetland habitat in the Portage area. For example, moving the levee alignment closer to the Wisconsin River would be highly undesirable. Clearing, filling and building in the floodplain, which would then be flood proofed, would undoubtedly occur up to the new levee. Hundreds of acres of wetlands could be lost in that manner and in our opinion, a plan of this type would contravene Executive Orders 11990 and 11988. We therefore, wish to be involved in the detailed planning of all proposed levee alignments.

The 11 miles of levee improvements proposed for the Left Bank Only option (Lewiston and Portage Levees) or 22 miles of levee improvements for the All (includes the Caledonia Levee) proposal would involve a much greater portion of the study area, and hence greater environmental disturbance, than the 4 miles proposed for the Portage Only alternative. According to your Standard Project Flood map, the majority of lands that flood besides residential Portage include the Pine Island and Swan Lake State Wildlife Areas (much of which is wetland), farmland, roads, and relatively undeveloped floodplain forests and shrub wetlands adjacent to the Wisconsin, Baraboo, and Fox Rivers. In our opinion, to construct several miles of levees to flood proof these lands is unnecessary and not worth the economic and environmental costs. These areas usually recover relatively quickly from occasional inundation and do not suffer the major damage that occurs to residential property. The environmental costs or effects of a large scale levee project include loss of floodplain wildlife habitat by larger levees designed to contain the SPF; loss of habitat by levee access roads during construction, and perhaps the most significant long term effect; displacement of wildlife habitat as development encroaches into the floodplain that would be flood proofed. Accordingly, we believe that with proper planning the "improvement of the Portage Levee only" proposal may be the best solution to alleviate flooding to the majority of residential Portage at comparatively low costs and still maintain a high degree of environmental protection for the abundant floodplain forests and other wetlands that abut the city. Our suggested levee plan for your detailed analysis in Stage 3 is as follows (Figure 4):

1. Align the new levee to closely approximate the Corps' permit jurisdiction line for the Fox and Wisconsin Rivers as regulated under Section 404 of the Clean Water Act of 1977 and Section 10 of the Rivers and Harbors Act of 1899 (see Figure 4 for FWS interpretation).

2. On the east side of the city, begin the levee at the junction of STH 51 and Ontario Street; extend it northeast along Ontario Street (just east of the houses) to the Chicago, Milwaukee and St. Paul Railroad tracks; continue northwest along the tracks to Wauona Trail Road and lastly, follow the road northeast to a point where the levee could tie

into STH 33. Highway 33 would have to be elevated approximately 5 feet in the Fox River area for 100 YF protection and obviously elevated more for SPF protection. Much of the land adjacent to the Fox River just northwest of STH 33 between Hamilton Street and the Portage Canal is wetland; this area should not be flood proofed by levees.

3. Flood proof or evacuate the few scattered dwellings east of our proposed Ontario St. Levee alignment that would not have flood protection.

4. On the south side of the city through town, align the levee as close as possible to the existing Portage Levee.

5. On the west side, follow the natural upland bluff line south of the houses along west Conant St. to Summit St. then to River St.; continue northwest riverward of the houses and end approximately at the STH 78 overpass. The topography is higher in this area and thus a levee may not be needed in some areas.

In our opinion, this plan is economically desirable as well as environmentally favorable because it "conceptually" provides flood protection to the majority of the residential city with a minimal amount of new levees required. We realize the plan would have to be analyzed for all appropriate flood control criteria.

IV. NEW UPSTREAM RESERVOIRS AND FLOOD STORAGE MODIFICATIONS TO EXISTING POOLS

The proposed alternatives of creating new upstream reservoirs, increasing the flood storage at existing dams, lowering the operating pool of upstream dams, raising structure heights of upstream dams, and modifying operation of the Prairie Du Sac Dam Spillways are handled briefly in Chapter 5. In each case, it is concluded that the increased storage capacity would not increase the flood control storage sufficiently to reduce the 100 YF discharge on the Wisconsin River below the minimum spill discharge of approximately 60,000 cfs.

Upstream Reservoirs - Dams can either benefit fish and wildlife or destroy them. Most assuredly, impounding a stream would cause many dramatic changes. Wildlife habitat would be permanently lost by flooding, including the valuable riparian corridor along the stream. The ecology of running water would shift to more of a lake type environment, which means changes in the flora and fauna communities as some species adapt and others expire. The stream fishery would be converted to a reservoir type which could force undesirable changes in the community structure. For exampe, if a trout stream were impounded much of it would likely become unsuitable for trout habitat because of the elevated temperature regime in the pool and discharge water.

Therefore, because of the significant environmental impacts associated with new upstream reservoirs on subwatersheds of the Wisconsin River, very close multiagency coordination would be required to determine whether or not dam(s) as a solution to flooding would best serve the public interest.

Modifications to Existing Upstream Dams and Reservoirs to Increase Flood Storage -

A significant impact of 1) raising the height of existing upstream dams, 2) lowering the operating pool of reservoirs, or 3) modifying the operation of the Prairie Du Sac Dam Spillways is that pronounced changes would occur in pool water levels and probably in seasonal fluctuation patterns. Again, fish and wildlife can benefit from reservoir fluctuation or be adversely effected by it. Timing in accordance with biological activities is perhaps the most critical factor. Pool fluctuation could generally benefit fish and wildlife if higher water levels occurred in the spring to maximize fish spawning habitat in the littoral zone of the flowage. Also, waterfowl would be forced to nest above high water consequently, nest losses from flooding would be either avoided or minimized. Higher fall water levels would inundate more aquatic vegetation and provide additional feeding and nesting areas for migrating waterfowl.

On the other hand, water levels that have a rapid daily fluctuation and extreme or erratic seasonal fluctuation are usually detrimental to fish and wildlife unless this measure is being used as a management technique to control nuisance species. Drawdowns at the wrong time of the season can cause such adverse environmental effects as leaving fish spawning areas high and dry and dewatering shoreline wetlands when migratory birds need them.

In summary, we would need more information before we could determine how the proposed modifications to existing upstream reservoirs would affect fish and wildlife resources. If the proposed reservoir modifications are pursued further as flood control measures, an environmental study of the reservoirs proposed for change would be the most appropriate and scientific course of action to determine lake specific impacts, especially which communities would benefit and which would not.

V. NON-STRUCTURAL SOLUTIONS

Non-structural solutions to flooding problems might include:

Floodplain Evacuation - Undoubtedly, there are situations where the public benefit of preserving high quality floodplain habitat would outweigh the costs of evacuation.

Floodproofing - It may not be practical to evacuate some structures located in the floodplain because of excessive costs. In these cases, flood proofing should be seriously evaluated as an alternative to an expensive and environmentally destructive structural solution, particularly where only a few sporadic structures need flood protection.

Floodplain Zoning - In our opinion, good floodplain zoning protects the environmental characteristics of the floodplain and also prevents the loss of life and property. A workable plan must be regulated, enforceable, and well understood by the public so a prospective developer can find out where it is safe to build. Floodplain zoning is especially valuable when flood prone cities like Portage are planning what direction/s the city should expand.

We believe non-structural solutions to flooding problems have historically been under emphasized and consequently, much unnecessary environmental damge to floodplains by structural measures have resulted. Non-structural solutions may be workable in certain geographic areas of the floodplain and therefore could comprise part of a combination of measures plan when the final comprehensive flood control plan for Portage is developed.

ENVIRONMENTALLY SENSITIVE AREAS

We consider the following resource areas as environmentally sensitive and should receive special consideration in plan development: the Pine Island and Swan Lake State Wildlife Areas, Baraboo River Floodplain Forest (Natural Area of Statewide Significance), greater sandhill crane nesting habitat, red-shouldered hawk nesting habitat (State Threatened species), speckled chub and black buffalo habitat (State Threatened fish species), and the Leopold Memorial Reserve (National Historic Landmark). The values of each area have been previously described either in this report or our Stage 1 report.

Table 3 rates our judgement of the magnitude of impact that each alternative would have on the above mentioned special resource areas. We listed an Ia (inadequate information) for those alternatives where project data was not sufficient to evaluate an impact rating. However, Stage 3 studies will allow us to refine more definitively probable impacts to each environmentally sensitive area.

ENDANGERED AND THREATENED SPECIES

To comply with Section 7 of the Endangered Species Act of 1973, as amended, you should contact the Area Manager, FWS, Region 3, Twin Cities Area Office, St. Paul, Minnesota to 1) obtain a list of federally endangered or threatened species that my occur in the study area 2) obtain information relative to your possible need to conduct a biological assessment of potential project caused impacts upon those species listed.

Specially designated species on the State endangered or threatened list known to occur in the study area are:

Birds

Endangered
double-crested cormorant (*Phalacrocorax auritus*)
bald eagle (*Haliaeetus leucocephalus*)
osprey (*Pandion haliaetus*)
peregrine falcon (*Falco peregrinus*)
common tern (*Sterna hirundo*)
Forester's tern (*Sterna forsteri*)

Table 3. Impact rating for each proposed alternative on known environmentally sensitive areas in the Portage study area.

	PISWA	SLSWA	NASWS	GSCNH	RSHNK	STF	LMR
DIVERSION CHANNELS							
Long Lake	Ma	Mi	Ma	Mo	Ma	Mo	Mi
Baraboo River	Ma	Mi	Mo	Ma	Ma	Mo	Mi
Fox River via Big Slough	Mi	Mi	Mi	Ma	Mo	Mo	Mi
CHANNEL MODIFICATIONS							
Caledonia Levee Outlet	Mo	Mi	Mi	Mi	Mi	Mi	Mi
Snagging and Clearing	Ma	Mi	Ma	Ma	Ma	Ma	Mi
Dredging	Ma	Mi	Ma	Mo	Ma	Ma	Mi
LEVEE IMPROVEMENT							
Portage Levee only (FWS proposed alternative)	Mi	Mi	Mi	Mi	Mi	Mi	Mi
Along the left bank only--Ia*							
All levees--Ia							
NEW RESERVOIRS--Ia							
INCREASED STORAGE OF EXISTING DAMS--Ia							

NON-STRUCTURAL MEASURES - Presumed minor for all areas but specific proposal must be known.

Legend
PISWA - Pine Island State Wildlife Area
SLSWA - Swan Lake State Wildlife Area
NASWS - Natural Area of State Wide Significance
GSCNH - Greater Sandhill Crane Nesting Habitat
RSHNK - Red-shouldered hawk nesting habitat (State Threatened Species)
STF - State Threatened Fish - Wisconsin River (speckled chub, black buffalo)
LMR - Leopold Memorial Reserve

Impact Rating
Ma - Major, mitigation not practical (irreversible)
Mo - Moderate, mitigation possible (reversible)
Mi - Minor or no appreciable impact - mitigation attainable (reversible)
Ia - Inadequate information to evaluate impacts

* Proposed levee alignments unknown

Threatened
Cooper's hawk (Accipiter cooperii)
great egret (Casmerodius albus)
red-shouldered hawk (Buteo lineatus) - nests in the study area

Fish - Wisconsin River

Threatened
speckled chub (Hybopsis aestivalis)
black buffalo (Ictiobus niger)

Species of major concern known to inhabit the study area are the red-shouldered hawk, speckled chub, and black buffalo. The hawk nests in floodplain woods. The chub inhabits the Wisconsin River in areas where fast current flows over sandy shoals, and the buffalo is found in the sloughs and backwaters of the river.

According to our information, the other bird species listed as having special state status are not known to nest in the study area. However, you should contact the WDNR Office of Endangered Species in Madison, Wisconsin to benefit from their flora and fauna survey information and also their comments on project caused impacts.

CONCLUSIONS AND RECOMMENDATIONS

1. All three diversion channels, the snagging and clearing alternative, and both dredging proposals would cause severe damage to fish and wildlife resources and be unavoidable and not practical to mitigate. If these alternatives are pursued, the Service would likely oppose them. However, a limited snagging and clearing or dredging proposal as part of a comprehensive flood control plan would warrant our further consideration. For those alternatives that consider new upstream reservoirs or modifications of existing reservoir operations, we would need more information to evaluate site specific impacts.

2. The FWS proposed levee alignment plan for the Portage Levee Only alternative, or a mutually agreeable modification of it, should be evaluated in detail during Stage 3 studies.

3. The Wisconsin Department of Natural Resources (WDNR), Bureau of Environmental Impact, should review the proposed flood control alternatives before Stage 3 studies begin. Their comments would be especially helpful pertaining to which alternatives from a State regulatory viewpoint could or would not be permitted.

4. Utilizing the Pine Island State Wildlife Area as a temporary flood storage area by breaching the Caledonia Levee Outlet may have merit, assuming the WDNR concurs.

5. To comply with S[illegible] [illegible]red Species Act of 1973, as amended, initiat[illegible] [illegible]ultation by contacting the Area Manager. For information p[illegible] [illegible]tat[illegible] endangered and threatened species statutes contact th[illegible] [illegible]ffice of Endangered Species.

6. All alternatives proposed for Stage 3 study should avoid through early planning the Leopold Memorial Reserve. The Service would likely oppose any plan that would physically modify or otherwise degrade this Reserve. Aldo Leopold's "shack" is a National Historic Landmark. The Reserve is underwritten by L.R. Head Foundation, 201 Waubesa Street, Madison, WI 53704 and we suggest you keep the Foundation informed on the status of the study.

7. Floodplain evacuation, zoning, and flood proofing should be evaluated in Stage 3 as part of a comprehensive flood control plan and applied in those areas of the floodplain where structural costs and/or environmental damage can be reduced.

We hope this report and our other previous correspondence (April 1, 1977, May 5, 1977, and February 1, 1979) will help your analysis of feasible flood control alternatives and we look forward to further input during Stage 3 to help you develop an environmentally acceptable plan.

Sincerely yours,

Ronald G. Spry

Ronald G. Spry
Acting Field Supervisor

cc: DuWayne Gebken, DNR, Madison, WI
U.S. EPA, Chicago, IL

REFERENCES

Becker, Dale & Gordon Myrah. 1969. Fish Collections in the Wisconsin River Between the Cities of Lake Delton and Portage. Unpublished Report, University of Wisconsin-Stevens Point.

Bennett, James A. 1978. Ecology and Status of Greater Sandhill Cranes in Southeastern Wisconsin. Unpublished M.S. Thesis. May.

The Wisconsin Society for Ornithology, Inc., 1976. Wisconsin Favorite Bird Haunts.

U.S. Army Corps of Engineers, St. Paul District. 1980. Wisconsin River at Portage Feasibility Study Hydrology and Hydraulics Appendix DACW37-78-C-0175. July.

U.S. Environmental Protection Agency, 1978. Biological Study of the Fox and Wisconsin Rivers. Unpublished report. October.

U.S. Fish and Wildlife Service, Office of Biological Services. 1980. A Handbook for Terrestrial Habitat Evaluation in Central Missouri.

_____. 1980. Riparian Ecosystems: A Preliminary Assessment of Their Importance, Status, and Needs.

_____. 1979. Classification of Wetlands and Deepwater Habitats of the United States.

_____. 1978. The Potential Effects of Clearing and Snagging on Stream Ecosystems.

_____. 1978. Western Stream Habitat Improvements Handbook.

_____. 1956. Wetlands of the United States, Circular 39.

Wisconsin Department of Natural Resources. 1980. Draft Environmental Impact Statement for the Wastewater Treatment Facilities, City of Portage, Wisconsin.

_____. 1979. Natural Areas of Statewide Significance. Unpublished report. November 30.

_____. 1979. The Vanishing Wild.

_____. 1976. Public Hunting Areas. Map.

_____. 1977. Endangered Species Program, Progress Report, 1975-76. Unpublished report.

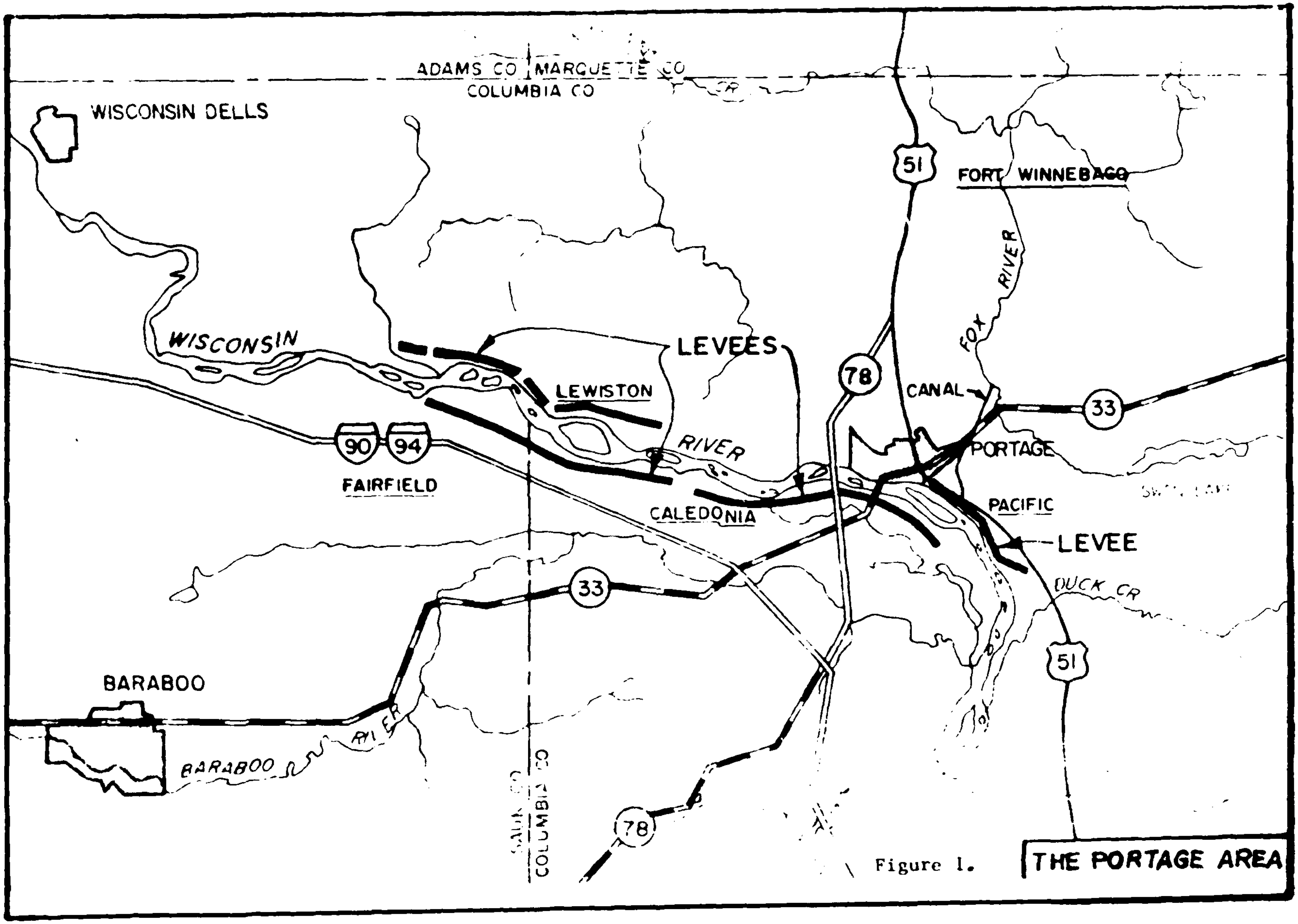
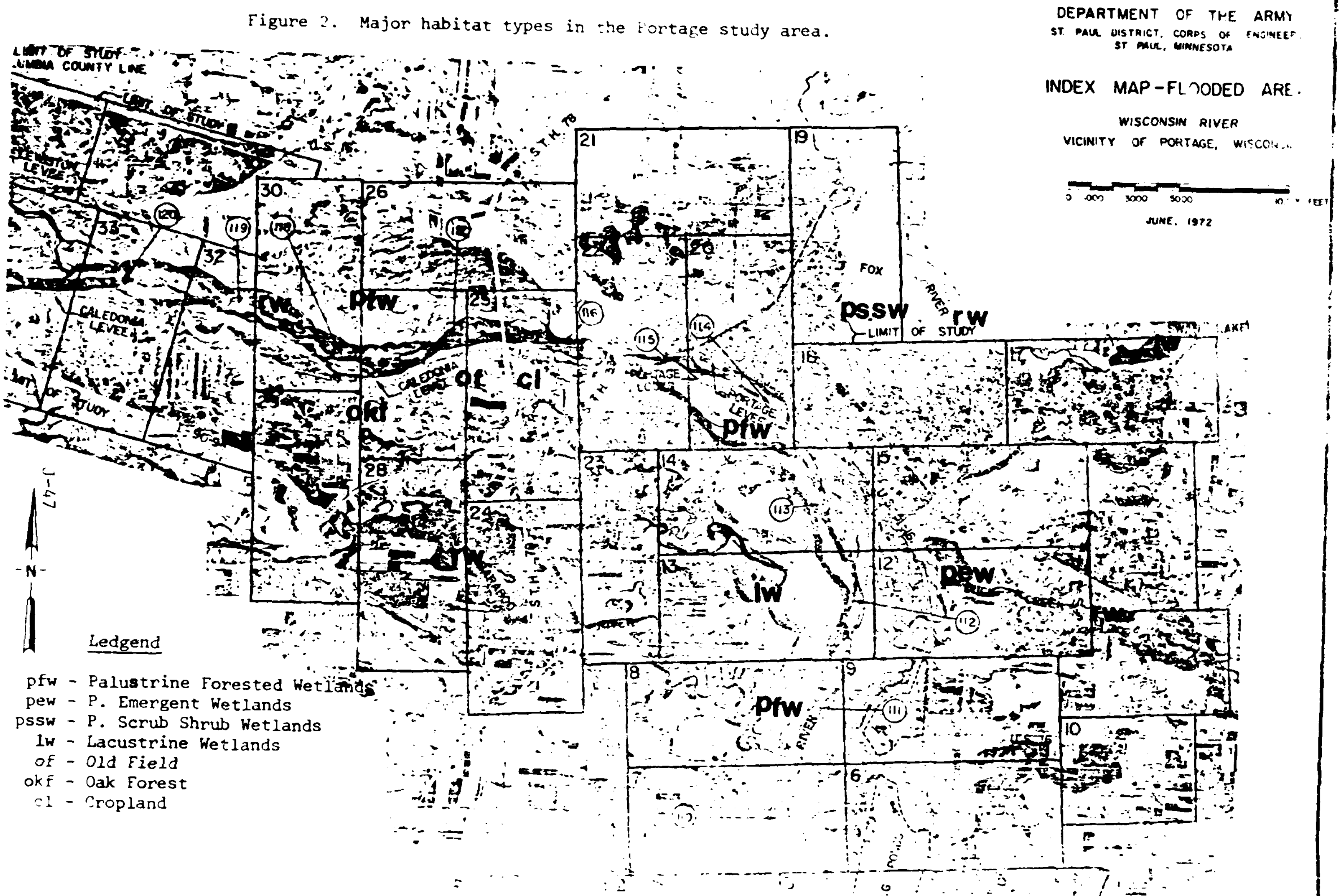

THE PORTAGE AREA
ADAMS CO
MARQUETTE CO
COLUMBIA CO
SAUK CO
WISCONSIN DELLS
WISCONSIN
RIVER
LEVEES
LEWISTON
FAIRFIELD
CALEDONIA
90
94
78
51
33
FORT WINNEBAGO
FOX RIVER
CANAL
PORTAGE
PACIFIC
LEVEE
DUCK CR
CR
BARABOO
BARABOO RIVER

Figure 1.

Figure 2. Major habitat types in the Portage study area.



Ledgend

pfw - Palustrine Forested Wetlands
pew - P. Emergent Wetlands
pssw - P. Scrub Shrub Wetlands
lw - Lacustrine Wetlands
of - Old Field
okf - Oak Forest
cl - Cropland

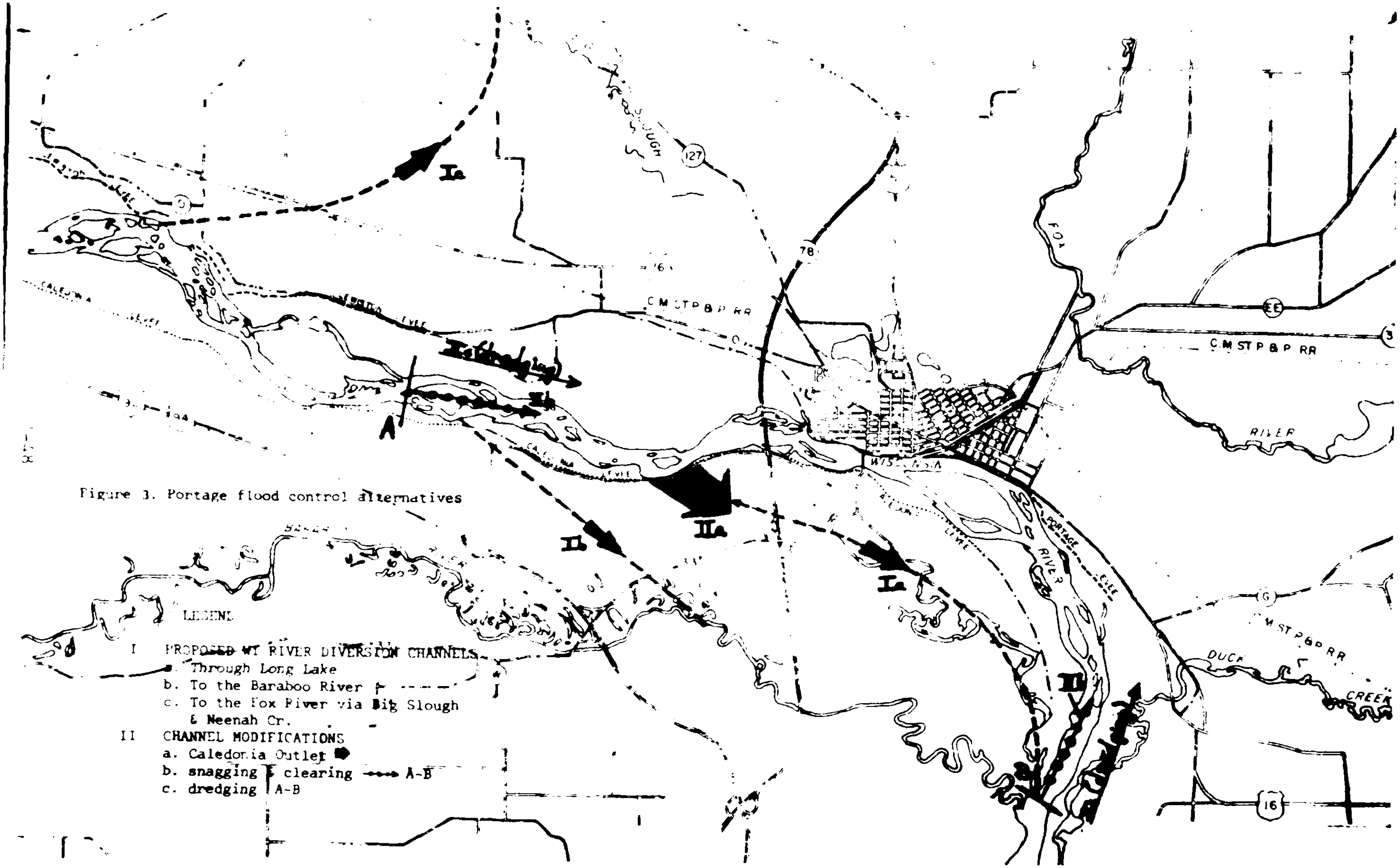
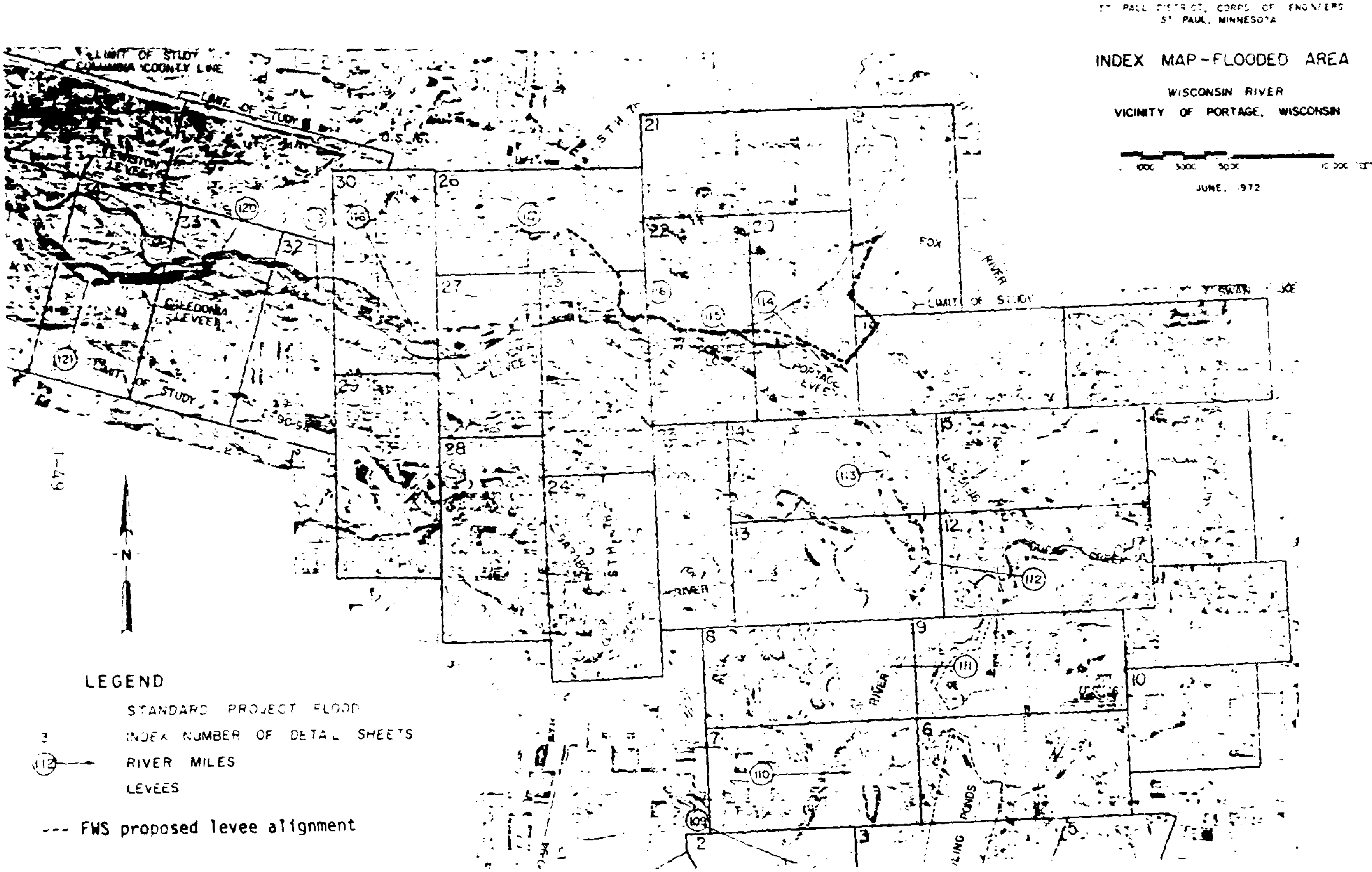


Figure 3. Portage flood control alternatives

Figure 4. Fish and Wildlife Service recommended levee alignment plan for the Portage Levee (only) levee improvement proposal.



DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL MINNESOTA 55101

PUBLIC MEETING NOTICE

CONCERNING

WISCONSIN RIVER AT PORTAGE FEASIBILITY STUDY FOR FLOOD CONTROL

WHEN

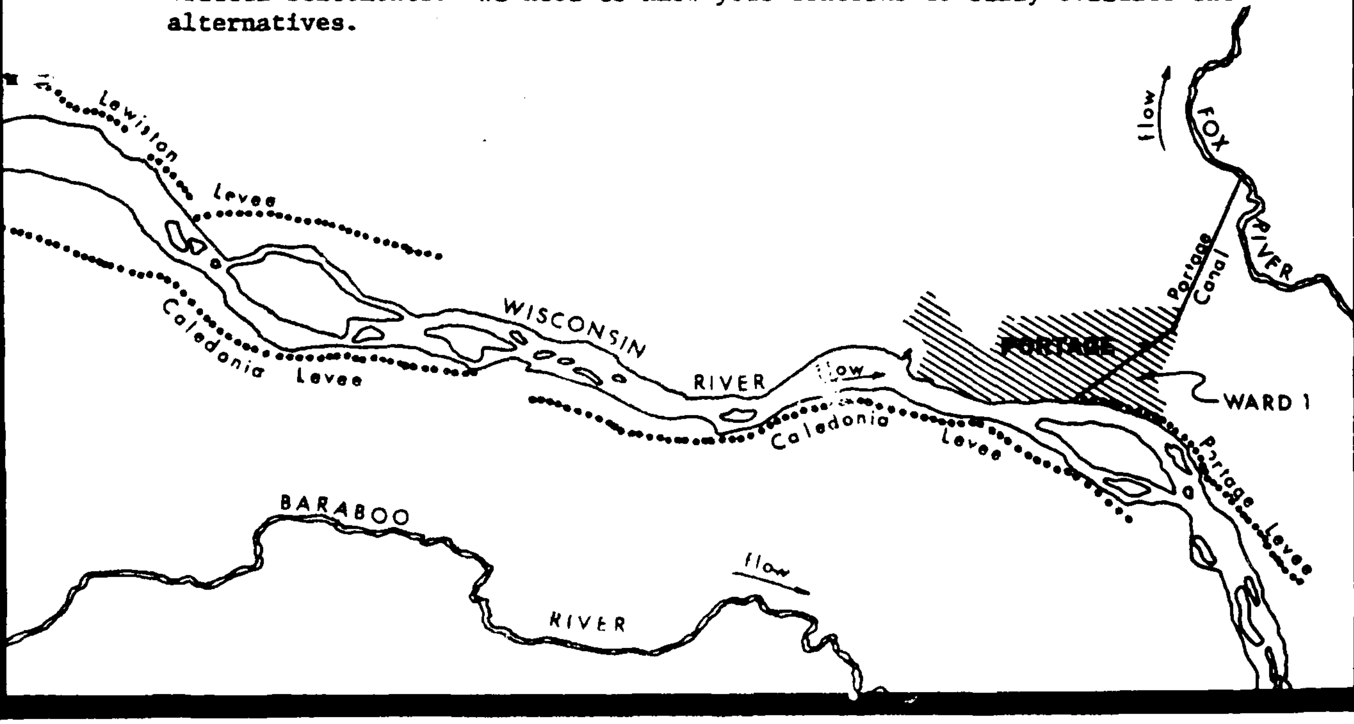
Wednesday, 29 April 1981, 7 p.m.

WHERE

Julia Rusch Junior High School Auditorium, 117 West Franklin Street, Portage, Wisconsin

PURPOSE

Flood damage reduction alternatives developed during the second of three stages of the study will be discussed. A "scoping" meeting for the EIS (Environmental Impact Statement) will be held in conjunction with this meeting. You will have the opportunity to state your views on the study and scope of the EIS. To ensure that the record is accurate, we suggest that you submit written statements. We need to know your concerns to fully evaluate the alternatives.



THE STUDY

Stage 1 of the study is documented in the Plan of Study completed in August 1977. This report discribes the flood problems and outlines study procedures. In stage 2, existing floodplain conditions were analyzed and flood damage reduction alternatives were developed. The results of stage 2 are presented in the Stage 2 Alternatives Report (January 1981). Copies of this report are available at the Portage Public Library, from the citizens committee, or by writing to this office. Stage 3 will assess in greater detail those alternatives that appear to be feasible. The results of stage 3 will be presented to Congress in a final report.

OBJECTIVES

The primary study purposes are to:

- Analyze existing floodplain conditions to provide a basis for regulations and flood insurance.
- Develop an acceptable flood damage reduction plan.
- Determine the potential for restoration of all or portions of the Portage Canal.

For the most part, the first objective has been accomplished--floodplain regulations are being developed, and the flood insurance study is well under way. Flood damage reduction alternatives have been developed and are summarized in this notice. Meeting the third objective will require additional Federal funds.

STUDY AREA

The study area includes the city of Portage and the adjacent townships of Lewiston, Caledonia, Pacific, and Fort Winnebago in Columbia County and Fairfield Township in Sauk County. The greatest potential for flood damages is in Ward 1 of Portage (the area south of the canal).

ALTERNATIVES

The following flood damage reduction alternatives were considered:

- Improvement of the Portage levee.
- Improvement of the Portage and Lewiston levees.
- Improvement of all levees.
- Outlet in the Caledonia levee.
- Channel clearing.
- Channel dredging
- Diversion channel to the Baraboo River.
- Diversion channel to Long Lake.
- Diversion channel to Big Slough.
- Increase in flood storage of existing reservoirs.
- New reservoirs.
- Nonstructural measures.
- No action.

Alternatives were evaluated on the basis of economics (the reduction in flood damages must be greater than costs), environmental concerns, and effectiveness in reducing flood damages. Alternatives selected for further study are:

* Improvement of the Portage levee.

* Improvement of the Portage and a portion of the Lewiston levees.

* Nonstructural measures.

  - Closures to make structures waterproof.
  - Small walls or levees around structures.
  - Raising of structures.

* No action.

SCOPING PROCESS FOR THE E.I.S.

The intent of this process is to involve, at an early stage, affected and interested organizations and individuals in determining what issues will be covered in environmental documents. We would like to know what important biological, cultural, recreational, and social resources you think might be affected by the proposed alternatives. The EIS will be included in the final report sent to Congress.

SCHEDULE

Draft feasibility report - March 1982.

Final feasibility report - January 1983.

If an acceptable plan is identified, it will be recommended to Congress for authorization. If funds are appropriated, advance planning and detailed design studies would begin, followed by construction.

NON-FEDERAL RESPONSIBILITIES

If any of the alternatives are to be implemented, the non-Federal requirements outlined on pages 80-82 of the stage 2 report will have to be met. Policy requires that the non-Federal sponsor provide all lands, easements, rights-of-way, and relocations and pay operation and maintenance costs. An alternate proposed cost-sharing policy would require that the non-Federal sponsor pay 20 percent of construction costs and all operation and maintenance costs and the State pay 5 percent of construction costs. The policy to be used will depend on the policy of the President and Congress at the time a plan is authorized.

The final feasibility report must include a letter of intent from a properly authorized non-Federal public agency stating that the agency is able and willing to cooperate as a project sponsor. Potential sponsors are the city of Portage, Columbia County, and the State of Wisconsin. At this time, to continue the study, we need a preliminary indication of the extent to which these potential sponsors are willing to contribute.

STUDY PARTICIPANTS

Federal agencies contributing to the study include the U.S. Geological Survey and U.S. Fish and Wildlife Service. The Wisconsin Department of Natural Resources will provide guidance throughout the study.

A citizens committee was established to obtain local views during planning. Committee members are:

Harold Vik (chairperson)	Art Bailey
Candy Bulgrin (vice chairperson)	Robert Hoffer
Mike Horkan	Ed Kramer
Francis W. Murphy	Leon Heinze
Hugo Traub	Kenneth Scherbert
Otto Tofson	Frank DeLoughrey
Sam Pate	Robert Irwin (advisory member)

William Badger

WILLIAM W. BADGER
Colonel Corps of Engineers
District Engineer

☆ U.S.GPO:1981-768-087/91-6

Mailing List

Mr. J. C. Hytry
State Conservationist
Soil Conservation Service
P.O. Box 4248
Madison, Wisconsin 53711

Mr. George Alexander, Jr.
Regional Administrator
Region V EPA
230 South Dearborn Street
Chicago, Illinois 60604

Liaison Officer
MN/WI Bureau of Mines
P.O. Box 1660
Twin Cities, MN 55111

Division Engineer
North Central Div, Corps of Eng.
ATTN: NCDPD/Dan Sturmon
536 South Clark Street
Chicago, IL 60605

District Engineer
U.S. Army Engineer District
Chicago
219 South Dearborn Street
Chicago, Illinois 60604

Federal Insurance Admin
ATTN: Wally Weaver
1 North Dearborn Street
Chicago, Illinois 60602

Bill Krug
Water Resources Div., U.S.
Geological Survey
1815 University Avenue
Madison, Wisconsin 53706

Ms. Deirdre Riemes
State Planning Office, Rm B130
1 West Wilson St., State Office
Building
Madison, Wisconsin 53701

Mr. Ronald Z. Fiedler
District Engineer, Dist. 1,
Division of Highways
1317 Applegate Road
Madison, WI 53713

Dennis Mahy, Forester
Dept. of Natural Resources
Box 139
County Admin. Building
Portage, WI 53901

Mr. Bob Roden, Director
Bureau of Water Regulation &
Zoning, Dept. of Natural
Resources, Box 7921
Madison, WI 53707

Hon. Everett V. Bidwell
State Senator, 27th District
612 Edgewater Street
Portage, Wisconsin 53901

Hon. Tom G. Thomson
State Representative
State Capitol-Rm 205 West
79th Assembly District
Madison, WI 53702

Orrin Anderson, Chairman
Columbia County Board of
Supervisors, Columbia County
Administration Building
Portage, WI 53901

Chairman, Zoning & Planning
Committee for Columbia County
County Administration Bldg.
Portage, Wisconsin 53901

Mr. Bob Irwin, Dir. of Planning
& Zoning for Columbia County
County Administration Bldg.
Portage, Wisconsin 53901

Chairman
Sauk County Board of
Supervisors, Sauk County
Courthouse
Baraboo, WI 53913

Gene Golke, Director
Columbia County Emergency
Government
Sheriff's Dept.
Portage, WI 53901

Mr. Kenneth Cummings
Chairman, Town of Fairfield
Route 1
Baraboo, WI 53913

Hon. Robert Mael
Mayor of Portage
115 West Pleasant Street
Portage, WI 53901

Mr. Francis W. Murphy
City Attorney
234½ West Wisconsin Street
Portage, WI 53901

Mr. Dick Smith
1st Ward Alderman
210 Brook Street
Portage, WI 53901

Mr. Michael Horkan
Dir. of Public Works
115 West Pleasant Street
Portage, WI 53901

Mr. Leon Heinze, Chairman
Town of Lewiston
Route 3
Portage, WI 53901

Mr. Lester Lehman, Chairman
Town of Caledonia
Route 2
Portage, WI 53901

Mr. Elvin Horton, Chairman
Town of Pacific
Route 2
Pardeeville, WI 53954

Mr. Cris Schroeder
Chairman
Town of Fort Winnebago
Route 1
Portage, WI 53901

Mr. ~lmer Fisk, Chairman
Town of Dekorra
Route 1
Poynette, WI 53955

Portage Free Public Library
804 Mac Farlane Road
Portage, WI 53901

Richard Kienitz
Milwaukee Journal
Madison Bureau
23 N. Pinkney Street
Madison, WI 53703

Portage Register
309 DeWitt Street
Portage, WI 53901

Mr. L. L. Sheerar
WI Valley Improvement Company
P.O. Box 988
501 Jefferson Street
Wausau, WI 54401

William L. Keepers
WI Power & Light Company
P.O. Box 192
Madison, WI 53701

Max O. Andrae, President
WI River Power Co.
P.O. Box 50
Wisconsin Rapids, WI 54494

Mr. Henry Abraham, President
Portage Canal Society
529 West Cook Street
Portage, WI 53901

Mr. Reed Coleman, President
L. R. Head Foundation
201 Waubesa Street
Madison, WI 53704

WPDR Radio Station
Box 1350
Portage, WI 53901

Mr. Robert Mitchell
Route 3
Poynette, WI 53955

Mr. Richard M. Rudolph
Owen Ayres & Associates
1300 West Clairemont Avenue
Eau Claire, WI 54701

Mr. Otto Festge
Home Sec. to Congressman Robert W. Kastenmeier
P.O. Box 1625
Madison, WI 53701

Harold O. Vik, Chairman
Citizens Committee
Box 340
Portage, WI 53901 (25 cys)

Cathy Grissom Garra
Planning Br., Water Division
Environ. Protection Agency,
Region V, 230 S Dearborn St.
Chicago, Illinois 60604

Larry Larson, Chief, Flood-plain-Shoreland Mgmt. Sec.
Dept. of Natural Resources
Box 7921
Madison, WI 53707 (2 cy)

Highway Commissioner
Columbia County Hwy. Dept.
Box 875
Wyocena, WI 53969

Honorable Lee S. Dryfus
Governor of Wisconsin
State Capitol
Madison, Wisconsin 53702

N. H. McKegney, Div. Manager
Chicago, Milwaukee, St. Paul & Pacific Railroad
433 West St. Paul Avenue
Milwaukee, WI 53201

Frederica Kleist
Secretary, Portage Canal Society
528 West Cook Street
Portage, WI 53901 (10 cys)

Director
Area Office, Div. of Ecological Serv., U.S. Fish & Wildlife
University of WI-Green Bay
Green Bay, WI 54301

Mr. Harvey Nelson, Reg. Dir.
U.S. Fish & Wildlife Service
Federal Bldg., Fort Snelling
St. Paul, MN 55111

Mr. John D. Cherry, Reg. Dir.
Lake Central Region
Heritage Cons. & Rec. Serv.
Federal Building
Ann Arbor, MI 48107

Mr. Carroll Besadny
Secretary
Dept. of Natural Resources
Box 7921
Madison, WI 53702 (8 cy)

Dr. Joan E. Freeman
State Archaeologist
816 State Street
Madison, WI 53706

Mr. Richard A. Erney
State Historic Preservation Officer, State Historical Society of WI, 816 State St.
Madison, WI 53706

1LT George Perantoni
HHC 17th Engineer Battalion
Fort Hood, Texas 76544

Te[illegible] [illegible]urdick
Chairman, Green Lake County Board of Supervisors, Courthouse, 492 Hill Street
Green Lake, WI 54941

Thomas McDowell, Chairman, Marquette County Board of Supervisors, Courthouse
77 West Park Street
Montello, WI 53949

Herman Brandt
Chairman, Winnebago County Board of Supervisors, Courthouse, 415 Jackson Street
Oshkosh, WI 54901

Hon. Robert W. Kastenmeier
House of Representatives
Washington, D.C. 20515

Honorable William S. Proxmire
United States Senate
Washington, D.C. 20510

Honorable Robert Kasten
United States Senate
Washington, D.C. 20510

Mr. William B. Mann IV
District Chief, Water Res. Div.
U.S. Geological Survey
1815 University Ave
Madison, Wisconsin 53706

Charles & Nina Bradley
Leopold Memorial Reserve
Route 1, Box 124A
Baraboo, WI 53913

Director, Midwest Region
National Park Service
1709 Jackson Street
Omaha, Nebraska 68102

Area Director
Region V, Federal Housing Admin.
US Dept of Housing & Urban Devl.
744 North 4th Street
Milwaukee, Wisconsin 53203

V.A. Zaske
622 W. Edgewater Street
Portage, Wisconsin 53901

Robert P. Doyle
Route 3
Portage, Wisconsin 53901

Leo R. Fredrick
Route 4
Portage, Wisconsin 53901

James F. DuFresne
Box 34, Route 2
Portage, Wisconsin 53901

F. A. Hansen
201 Minnehaha
Portage, Wisconsin 53901

Jim Liehmke
839 Hamilton
Portage, Wisconsin 53901

Portage Canal Society Inc.
Portage, Wis.
April 8, 1981

Harold Vik
Wisconsin River Flood Control Citizens Committee
P O Box 340
Portage, Wisconsin 53901

Dear Mr. Vik:

It has came to the attention of the Portage Canal Society Incorporated, that there is a question of the continuing study of the Wisconsin Flood Control Study being dropped.

The Canal Society feels it is esential that the study goes forward. The Wisconsin River Lock is a safety measure in times of high water. The lock was rebuilt in 1928. In 1951, the lower gates were welded shut. Since that time, there has been no repair to the locks or the gates. A quick inspection of the gates shows deterioration. These gates with the pressure of high water could give away and flood through the Canal and on down the Fox River. Some of the Canal Banks would not hold this flow. Recently, there has been caveins along the canal banks, where the storm sewers empty into the canal. This causes erosion and weakens the canal banks.

There is the question of:"erosion at the base of the locks." This is hard to tell as they are below the water level. It would take a knowledgable person to determine this aspect.

What would happen to the First Ward, if the canal could not hold the water? The Canal acts as a drainage system for the First Ward, which has a high level of groundwater.

There are those who think that a flood disaster could not happen in Portage. It has happened in other places. Why not lock the "barn before the horse is stolen instead of after?"

The Portage Canal Society supports further study of the Wisconsin River.

From a letter dated April 1, 1981 to Frederica Kleist from Rep. Robert Kastenmeier:" with respect to the Corps study of the Portage Levee System, it is not affected by the budget cuts." There has been considerable money spent on this effort and to drop it would be a waste of both time and money.

Sincerely,
Henry Abraham
Henry Abraham, Pres. Portage Canal Soc. Inc.
529 West Cook St.
Portage, Wis. 53901

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

April 23, 1981 IN REPLY REFER TO: 3550-3

Colonel William W. Badger
District Engineer
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

Re: Stage 2 Alternatives Report for the Wisconsin River at Portage, Wisconsin, Feasibility Study

We have distributed the Stage 2 report throughout our Department and asked for comments. A general summary of the comments is listed below.

General Comment

1. We concur with the Corps recommendation for Stage 3 study of the most feasible flood control alternatives, (1) improving the Portage levee with or without new levees in Ward 8 of the City and Lewiston Township, and (2) nonstructural measures, with emphasis on Lewiston and Caledonia township.

2. A major effort should be made in Stage 3 to consider a combination of the structural and nonstructural alternatives.

3. Maps and/or tables providing information relative to the number and types of structures flooded and the severity of flooding potential would be helpful to adequately review the alternatives.

4. The benefit cost summaries provide us with the results of the calculations but few of the assumptions used. In order to be able to comment on the cost-benefit calculations, which are heavily weighed in choosing alternatives, we must know how they were calculated.

5. We suggest additional means of calculating benefits and costs. For example, the costs per structure protected is $9,765 for the Portage levee (standard project flood), $25,839 for the Portage and Lewiston levees, and $56,620 per structure for all levees. Other calculations in absolute terms, instead of ratios, help place financial implications in perspective. The cost per structure of relocation and on-site flood proofing should also be examined.

6. The Corps position regarding zoning of areas protected by the levees should be stated. The impact on land use and land values should have been more thoroughly explored especially where levee construction will have a direct impact on regulatory floodplain boundaries.

7. The raising of the Portage (and Lewiston) levees may have adverse effects on the Caledonia levee during flood events. This could increase the cost of maintenance and chances for structural damage to the Caledonia levee. These factors need to be considered in terms of economics and from the standpoint of potential increase in flood damages to private property.

Specific Comment

1. Page 14a - The graph shows the 1973 flood on the Wisconsin River had higher water levels than the 1938 flood, while the text states the 1938 flood had a record flow in cfs. Normally, one would expect the highest level flood to have the greatest flow. This point requires further discussion.

2. Page 15 - It is stated that no information is available on flood damages to communities along the Upper Fox River resulting from Wisconsin River overflows. On page 78, in discussions of benefits from the Portage levee, it is stated that about 70% of the benefits are from reduced flooding in Portage while about 25% are from reduced flooding along the Upper Fox. How was the 25% calculated?

3. Page 40 and 44 - Do the calculated benefits and costs include impacts on the Town of Caledonia/Blackhawk Park and the loss of 45 acres or more of forested land?

4. Page 47 - Creating better levees will aggravate downstream and upstream flooding. What are the magnitudes for various flood levels and the potential dollar losses attributed to the higher levels? Were these figures used in the cost-benefit analysis? Has consideration been given to the possibility of other downstream communities wishing to construct levees to counteract the effects of the Portage project?

5. Page 70 - Flood Insurance - A discussion of this alternative, including how it works and implementation rates, is necessary so the citizens can evaluate its potential usefulness.

6. Page 71 - The discussion of flood warning and evacuation does not allow an assessment of its usefulness. Is it an adequate system and can it be improved to reduce losses?

7. Pages F-23 and 24: Will the alternative suggested by the Fish and Wildlife Service for the Portage levee be considered in more detail in future studies?

There has been some concern about the legal and regulatory aspects of the alternatives involving levee construction. These include easements, floodplain regulations and laws pertaining to construction of such levees in or adjacent to navigable waters of the state. Since these concerns were not intended to be addressed in the report we will be commenting on these issues

under separate cover. We realize the Stage 2 report was to evaluate the many different alternatives and select those for further study. Stage 3 will incorporate regulatory and legal restraints.

Thank you for the opportunity to review and comment on this report.

Sincerely,
Bureau of Water Regulation & Zoning

Robert W. Roden

Robert W. Roden, P.E.
Director

BR:sle

cc: Doug Morrissette - SD
Stan Druckenmiller - EI/3
Jim Addis - FM/4
John Keener - WM/4
George Meyer-ADM/5
Mark Riebau-WRZ/5

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

April 24, 1981

IN REPLY REFER TO: 3500

Mr. Louis Kowalski
St. Paul District, C.O.E.
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Mr. Kowalski:

Re: Portage Flood Control Project, Columbia County

At the April 2, 1981, meeting between representatives of the Corps of Engineers, Fish and Wildlife Service, and the Wisconsin Department of Natural Resources, you expressed an interest in the Department's position with regard to the possible upgrading of the Portage levee.

The following are our responses to the three questions which you raised. Obviously, given the preliminary nature of the information available and the short time period for our response, we cannot give you answers at this time which would be binding on the Department.

1. Could the levee be expanded riverward to meet Corps of Engineers design standards? We do not see any unresolvable problems with the concept of expanding portions of the Portage levee in a riverward direction where extension farther onto the upland is not feasible because of existing development. However, depending on the magnitude of expansion and the area in which it occurs, we may have environmental and/or legal concerns with the proposal once it is developed in greater detail.

2. Could sand be obtained for levee construction by dredging of the Wisconsin River? While we do not have major concerns with such an activity at this time, there may be areas of the river (sand bars or other features used by wildlife) which we would prefer not to see disturbed. Before we could provide you with a more specific answer, we would need more detail on the timing and location of such a dredging operation, as well as the manner in which dredging would occur.

3. Would stage increases of 0.8-0.9 foot (regional flood) and 2.0-3.0 feet (standard project flood) be acceptable to the Department as a result of an improved levee? Any increase in flood heights would have to be handled consistently with Chapter NR 116, Wisconsin Administrative Code. While increases in flood heights of up to 0.1 foot are generally acceptable, greater increases must be formally recognized by the local unit of government, and appropriate legal arrangements must be made to compensate owners of private property which would suffer increases in flood damages. An additional concern of the Department would be the effects of such increased flood heights on the Caledonia levees which are, and would likely still be, maintained by the Department. The increase in flood height could increase the likelihood of structural damage to the levee, as well as damage to private property behind the levee. These factors should be carefully considered in the economic analysis of the project during the Stage 3 study.

I trust that this information is responsive to your questions. The Department is interested in seeing the study process completed so that the feasibility and likely effects of flood control activities in the Portage area are more thoroughly evaluated. Please call me at 608-266-8034 if you have any questions.

Sincerely,
Bureau of Water Regulation & Zoning

Robert W. Roden

Robert W. Roden, P.E.
Director

RWR:mn
cc: D. Morrissette-SD
Craig Adams-DOA
G. Meyer-ADM/5
L. Larson-WRZ/5
J. Addis-FM/4
J. Keener-WM/4

STATE OF WISCONSIN
OFFICE OF THE GOVERNOR
STATE CAPITOL
MADISON. 53702

LEE SHERMA: DREYFUS

Mailing Address:
P.O. Box 7863
Madison, WI 53707

Telephone Number
(608) 266-1212

April 28, 1981

Colonel William W. Badger
St. Paul District of Corps of Engineers
1186 U. S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

My staff has carefully reviewed the Stage 2 Alternatives Report for the Portage, Wisconsin flood control feasibility study.

I am concerned by the potential for failure of the existing levee system at Portage. Therefore, it is essential that the Corps of Engineers continue its study activities to determine the feasibility of a federally assisted project to deal with the area's flood control problems. The State 2 report highlights the significant benefits which a flood control project could provide to the Portage area and to the communities in the Upper Fox River Basin.

Your March 11, 1981, letter and the Alternatives Report stress the need to address the issue of local project sponsorship. Identification of a project sponsor is a difficult and complex matter involving controversial constitutional, legal, fiscal and intergovernmental issues. It is unrealistic to expect an immediate decision on this matter, especially in the absence of detailed cost information and given the uncertainties of the federal policy regarding cost sharing.

While the question of local sponsorship has not been determined, I am confident that the issue will be resolved before the completion of the final feasibility report. A letter of intent from a project sponsor, or group of sponsors, will be submitted at that time.

It is my understanding that the City of Portage strongly supports the completion of the feasibility study and that they remain open to evaluating the question of their participation in the project. I can assure you of the State of Wisconsin's strong interest in this project. We remain open to exploring the full range of options for state participation in the project.

I urge your office, the North Central Division Office and the Office of the Chief of Engineers to continue the feasibility study for Portage area flood control. The State of Wisconsin and the City of Portage's commitments to fully and mutually explore possible participation in the project provide a clear basis for completing the feasibility report. As is normally the case with Corps projects, the State 3 work will permit the formal identification of a project sponsor, including the development of the requisite letter of intent.

Sincerely,

Lee Sherman Dreyfus

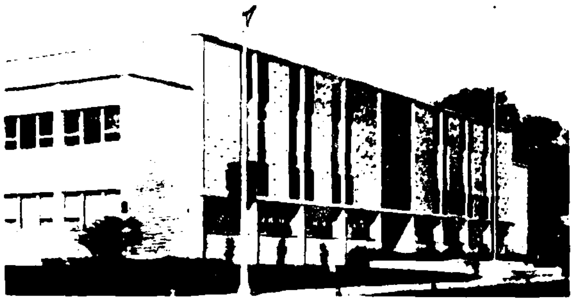
Lee Sherman Dreyfus
GOVERNOR

sm

cc: Mr. Carroll Besadny, Secretary
Department of Natural Resources

Mr. Francis P. Riley, Mayor
City of Portage

Mr. Harold O. Vik, Chairman
Citizens Committee
Portage, Wisconsin



COLUMBIA COUNTY ADMINISTRATION BUILDING

Columbia County
BOARD OF SUPERVISORS

Portage, Wisconsin 53901
Phone 742-2191

April 30, 1981

Mr. William W. Badger
Colonel, Corps of Engineers
Department of the Army
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Re: NCSED-PB

Dear Mr. Badger:

I am in receipt of your letter of March 11, 1981, relative to the Stage 2 Alternatives Report for the Wisconsin River at Portage feasibility study.

This matter was discussed at the annual meeting of the Columbia County Board of Supervisors on April 21, 1981. In light of the confused status relative to ownership and responsibility for the levies, I am not authorized by the Columbia County Board of Supervisors to inform you that Columbia County is able and willing to act as a project sponsor.

However, I have been directed to inform you of the county's strong support for the levy improvement program in general. It is our sincere hope that, as this project proceeds, Columbia County may be of assistance to whichever unit of government acts as project sponsor. We will make all information at our disposal available, together with the county's moral support.

If we can be of assistance, please feel free to contact us.

Very truly yours,

ORRIN ANDERSON
Chairman of Columbia County
Board of Supervisors

/cl

8 APR 1981

Colonel William W. Badger
District Engineer
U.S. Army Engineer District, St. Paul
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

We have reviewed the Stage 2 Alternatives Report for the Wisconsin River at Portage, Wisconsin flood control feasibility study. The report investigates alternatives which reduce flooding in the City of Portage, adjacent townships, and communities along the upper Fox River. Based on the results of this report, alternatives selected for further study are: 1) improvement of the Portage levee, 2) improvement of the Portage levee and a portion of the existing Lewiston levee, 3) non-structural measures, and 4) no-action. These alternatives will be studied in a Stage 3 Report and Environmental Impact Statement (EIS).

We reviewed the Stage 2 Report to identify areas of significant environmental impact in the interest of scoping the major issues to be addressed in the EIS. The Stage 2 Report and the proposed Stage 3 work items (also contained in the report) indicate that the study of a number of issues will occur. Among these are a hydrologic and hydraulic analysis, and a biological analysis. We are particularly interested in the structure and function of aquatic communities and their response to hydrologic modifications occuring as a result of levee improvements. Thus, we would like to see a detailed analysis of the aquatic ecology of the project area, and an assessment of the ecological changes which may take place under each levee improvement alternative.

Due to resource constraints, we are unable to attend the scheduled scoping meeting for this project. We hope the written comments provided in this letter are sufficient for the scoping effort. Feel free to call Mr. James Hooper of my staff (312/886-6694) if you have any questions about our comments or need to coordinate this project with us further. Also, please notify us should additional project alternatives or new environmental issues develop during the scoping/pre-EIS processes.

Sincerely yours,

James P. Hooper for

Barbara Taylor Backley, Chief
Environmental Impact Review Staff
Office of Environmental Review

FRANK DeLOUGHERY
ROUTE 2, BOX 257
PORTAGE, WIS. 53901

May 6, 1981

Mr. John Bailen
St. Paul District Corps of Engineers
1135 U. S. Post Office & Customs House
St. Paul, Minnesota 55101

Dear John:

In 1978 The Democratic Party of Columbia County, Wisconsin, adopted a resolution to go on record as favoring Improvement of the Portage Levee System. I was delegated to appear before the platform committees of the Second district convention and of the state convention. Both committees adopted resolutions for approval by the state convention.

The two enclosed papers containing the data I had available at the time were distributed to delegates and media representatives at the convention. You will note that some of the information, especially statistics on volume of water, have since been revised.

Contrary to opinions expressed at the April 16 meeting in Portage, people throughout the state are concerned with the levee problem when it is brought to their attention, and, if they are aware that it is greater than a local problem.

Sincerely,

Written for
1978 State convention
distributed on floor

DEMOCRATIC PARTY
of
Columbia County

NEGLECTED LEVEE ENDANGERS ENTIRE FOX RIVER VALLEY

The following information is verified in files of the DNR, the former Portage Levee Commission, and in state of supreme court case records.

The Portage Levee System properly should be called the Wisconsin-Fox River Valley Levee System, because it protects the entire Fox Valley from Wisconsin River floods that could wreak disaster to life, land, utilities, and industry all the way to Green Bay.

The levee system consists of about eighteen miles of sand dikes on both sides of the Wisconsin River in the towns of Lewiston and Caledonia, ending south of Portage.

Documentary evidence shows that, at low water, the Wisconsin River is about eight feet higher than the Fox. During high water, the difference can be as much as twenty feet, and there is only a mile and a half sloping plain between the two rivers.

The flow, at the hundred year level, is estimated at 115,000 cubic feet per second or 414,000,000 cu. ft. per hour. Testimony at hearings indicates that the hundred year flood plain within ten miles of Portage extends to 45,000 acres. If the levee should breach, this 414,000,000 cu. ft. of water per hour, plus the 45,000 acres flood plain, would surge down the mile and a half to the tiny Fox River creating devastation all the way to Green Bay, and Lake Michigan.

There also is the possibility that such a rush of water could cut a channel permanently changing the oourse of the Wisconsin River. This would leave the Prairie du Sac Hydroelectric dam useless, ruin Lake Wisconsin tourism, and further depress industry along the lower Wisconsin. Also, it would greatly diminish the flow of water to the nine foot shipping channel of the upper Mississippi.

Actually, it would take much less than the hundred year flood to cause vast destruction along the Fox River Valley. In 1938, the levee did breach, but some local people drove school buses into it to seal off the flow with the help of sandbags. At flood times, in early Wisconsin history, it was posssible for travelers to go from the Wisconsin to the Fox River without getting out of their boats.

Cost of reconstructing the levee was estimated recently at about $5 million--not much considering the threat to the public safety.

DEMOCRATIC PARTY

of

Columbia County

FRANK DeLOUGHERY
Portage, Wis. 53901

Re: THE PORTAGE LEVEE SYSTEM

The present condition of the Portage Levee system poses a threat to the entire Fox River Valley and the lower Wisconsin River Valley.

The governor can prevent a catastrophe that could be the worst in United States history.

Reconstruction of the levee is not a controversial proposition. No party, faction, or group opposes its reconstruction. The present situation results from neglect by elected republican members of the legislature.

Reconstruction has been endorsed by the 2nd District party and accepted by the state convention platform committee.

The argument that the state may not expend funds for reconstruction is in error. While the levee once may have been looked upon as a public improvement, now it can be regarded only as an awesome threat to the public safety. The governor is requested todeclare that reconstruction is not a public improvement, but the elimination of a dangerous threat to a great portion of the state of Wisconsin.

DEMOCRATIC PARTY

of

Columbia County

In 1938 the people up river fro Portage were riding shotgun on the levee to prevent people from Portage from blowing up the levee to relieve the pressure on Portage.

With a hundred year flood plain of 45,000 acres within ten miles of Portage, it is almost impossible to arrive at a reasonable zoning and planning program, although Columbia County has proved a model for the est of the state in its zoning ordinance.

An entire ward of the city is prevented from building and improving its dwellings and other buildings.

If the levee broke and the river flowed into Lake Michigan, the shoreline damage would be tremendous.

At flood state, prior to building of the levee, it was possible to go from the Wisconsin to the Fox River without getting out of the boat.

The chief re son the haz rd has been publicized so little is that the Corps of Engineers decided that reconstruction cost could be justified by the benefit to the City of P rt ge alone. Therefore it was not necessary to do a study of the probable damage to the Fox River Valley

United States Department of the Interior

FISH AND WILDLIFE SERVICE
TWIN CITIES AREA OFFICE
530 Federal Building and US Court House
316 North Robert Street
St. Paul, Minnesota 55101

IN REPLY REFER TO:

Colonel William W. Badger
District Engineer
U.S. Army Corps of Engineers
  St. Paul
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

In accordance with our scope of work for Fiscal Year 1982, this provides the U.S. Fish and Wildlife Service's (FWS) Stage 3 report to accompany your draft Feasibility Report for Stage 3 studies on the Portage Flood Control Project, Columbia County, Wisconsin. Recognize that it may be necessary to supplement this report prior to inclusion in your final Feasibility Report if, in the interim, new information becomes available or if significant changes occur in project design(s).

This report is submitted in accordance with the requirements of the Fish & Wildlife Coordination Act (48 Stat. 401, as amended 16 U.S.C. 661 et seq.). They are also consistent with the National Environmental Policy Act of 1969 and Presidential Executive Orders 11988 and 11990 on Floodplain Management and Protection of Wetlands.

STUDY AREA

The main study area is the Wisconsin River floodplain from the Columbia-Sauk County line near the village of Lewiston, downstream through Portage to the Interstate 90-94 bridge. Also included are portions of Duck Creek and the Baraboo River as affected by Wisconsin River backwater (for approximately 8 miles above the mouth of each), and the Fox River basin as affected by Wisconsin River overflows. The municipalities within the study area generally include the city of Portage and the townships of Lewiston, Caledonia, Pacific, and Fort Winnebago in Columbia County and the township of Fairfield in Sauk County (Figure 1). Please reference our Stage I and II reports dated February 1, 1979 and January 16, 1981, respectively, for detailed descriptions of the fish and wildlife resources of the project area and also for the general impacts upon those resources of a range of other flood control alternatives considered at Portage to date.

FISH & WILDLIFE HABITAT - WITHOUT THE PROJECT

Our Stage II report described the primary habitat types and associated fish and wildlife species that could be affected by the various project alternatives. Since we will be referring to them frequently, they are listed below and further classified in Table 1.

1. Palustrine Forested Wetland[1/] - bottomland floodplain woods occurring mainly along the Wisconsin and Baraboo Rivers. Prevelent vegetation comprising this habitat type are swamp white oak, silver maple, black willow, river birch, cottonwood, American elm, box elder, and black, green, and white ash. The understory is dominated by a diverse sedge (*Carex sp.*) community. Wildlife known to inhabit or use the floodplain woods at Portage include white-tailed deer, ruffed grouse, woodcock, red-shouldered hawk, osprey, barred owl, numerous songbirds (e.g., red-headed woodpecker, bluejay, kingfisher), raccoon, red and gray squirrel, cottontail, beaver, and river otter.

2. Palustrine Scrub-Shrub Wetland - much of the wetlands adjacent to the Fox River to the north and east of Portage are shrub wetlands. Typical vegetation composing the community are silver maple, red-osier dogwood, cottonwood, tag alder, willow (*Salix sp.*), and reed canarygrass. The associated wildlife community includes white-tailed deer, woodcock, ruffed grouse, ring-necked pheasant (winter cover), raptors (e.g., red-tailed hawk), cottontail, and several species of small mammals, reptiles, and amphibians.

3. Palustrine Emergent Wetland - a wetland type that is especially abundant along Duck Creek, but is also numerous in the ponds, potholes, and old river oxbows of the study area. The vegetative community includes river bulrush, spikerush (*Eleocharis sp.*), bluejoint, arrowhead (*Sagittaria sp.*), water plantain, phragmites, sedge, and cattail. These wetlands provide excellent waterfowl (e.g., Canada goose, mallard, blue-winged teal) breeding and feeding habitat as well as prime habitat for wading water birds (e.g., great blue and green herons, great egret, American bittern, greater sandhill crane), and furbearers (e.g., muskrats, mink, otter). Emergent wetlands also provide spawning and nursery habitat for fish such as northern pike, perch, and largemouth bass.

4. Field - This type of habitat is especially evident on the Pine Island State Wildlife Area (PISWA) on the south side of the Wisconsin River, just west of State Highway 78. Prairie grass fields are used by ring-necked pheasant, quail, gray partridge, mourning dove, meadowlark, badger, several species of small mammals, and raptors which prey upon them.

[1/] Classification of Wetlands and Deepwater Habitats of the United States, USDI, Fish and Wildlife Service, December, 1979

Table 1. Classification of the Major Wetland Types in the Portage Study Area

Type	System	Class	Subclass	Water Regimen Modifer	Dominant Vegetative or Macroinvertebrate Types	Subordinate Vegetative or Macroinvertebrate Types	Primary Location
7	Palustrine	forested wetland	broad-leaved deciduous	semipermanently flooded	swamp white oak	river birch, ash, silver maple	Wisconsin and Baraboo River floodpains
6	Palustrine	scrub-shrub wetland	broad-leaved deciduous	seasonally flooded or saturated	tag alder	silver maple, red-osier dogwood, willow, reed canarygrass	Fox River floodplain and the Big Slough area
3-5	Palustrine	emergent wetland	persistent	semipermanently flooded	sedges	cattail, river bullrush, bluejoint, phragmites, spikerush	Duck Creek, Long Lake area, the oxbows of the Baraboo and Wisconsin Rivers and most wetlands between STH 51 and the Wisconsin River floodplain forest
	Lacustrine	unconsolidated bottom	mud or organic	permanently flooded	*	*	Long, Silver and Swan Lakes and Lake George
	Riverine	unconsolidated bottom	sand or mud	permanently flooded (perennial streams)	Diptera	Amphipoda, Gastropoda	Fox River
					Diptera	Trichoptera, Gastropoda	Wisconsin River
					*	*	Baraboo River, Duck and Neenah Creeks

Note - Classification based on USFWS - Wetlands of the United States, Circular 39 and Classification of Wetlands and Deepwater Habitats of the United States

* Dominant and subordinate orders of macroinvertebrate species unknown

5. Oak Forest - Farther west but in the same area of the PISWA, the Field habitat grades to Oak Forest. White oaks, river and paper birch are typical along with cedar, sumac, pine plantings, and tag alder shrubs. Ruffed grouse, white-tailed deer, red and gray squirrel and cottontail are some of the species that use these areas.

6. Cropland - Corn and alfalfa are the principal crops grown. Ring-necked pheasants, quail and gray partridge are common near intensively cultivated farmlands where shrubs and brushy fence rows are present.

7. Lacustrine Wetland - includes those water bodies such as lakes and ponds greater than 20 acres. Long Lake, Silver Lake, Lake George, and Swan Lake are examples of Lacustrine Wetlands in the study area.

8. Riverine Wetland - includes those wetlands and deepwater habitats within a channel, and usually flowing water systems. The Wisconsin, Baraboo, Fox Rivers and Neenah and Duck Creeks are Riverine Wetlands in the study area.

Our Stage 1 report described the fish and other aquatic life that inhabit the lakes, rivers, and creeks of the Portage area.

PLANS OF DEVELOPMENT AND IMPACTS - WITH THE PROJECT

Our analysis evaluates the flood control alternatives listed below. The latter are based on the conclusions of your January, 1981 Stage II Draft Feasibility Report and results of technical meetings among the Corps, Wisconsin Department of Natural Resources (WDNR) and the Service.

Our acreage calculations of fish and wildlife habitat affected by the various levee alternatives are based on data contained in the Stage II Feasibility Study Report and also, assumptions obtained from your Environmental Resources Branch. We are assuming the levee slopes are generally 3:1 riverward and 5:1 landward and that an additional 200 foot corridor, excluding the area occupied by the existing levees, would be required to renovate the existing levees at Portage.

ALTERNATIVE I Improve the Portage Levee

A. Improve the Existing Portage Levee

The existing Portage levee would be raised and widened along approximately 13,800 feet of its existing alignment from the Portage Canal downstream to where the Portage levee ties into State Trunk Highway (STH) 51. The Service has two primary concerns with this portion of the alternative. As proposed, the first 6,000 feet of levee improvement (beginning at the Portage Canal) would encroach into the Wisconsin River channel approximately 200 feet if the 3:1 riverward and 5:1 landward slope criteria are used.

Accordingly, approximately 28 acres of shallow riverine backwater habitat would be eliminated which would cause an unnecessarly loss of aquatic habitat and an undesirable loss of floodplain conveyance capacity. Therefore, to minimize adverse aquatic impacts by levee encroachment, we recommend that levee construction along this 6,000 foot length incorporate appropriate structural design modifications to allow for a 1:1 riverward slope or as near to that as feasible. Also, recognize that levee development must be compatible with Wisconsin's Flood Plain Management Program as described in Chapter NR 116 of the Wisconsin Administrative Code, portions of which state:

> "NR 116.13 Uses in floodway areas. (1) Prohibited Uses. The following uses are generally prohibited in floodway areas; Any fill, deposit, obstruction, excavation, storage of materials, or structure which, acting alone or in combination with existing or future similar works, will cause an increase equal to or greater than 0.1 foot (3 cm.) in the height of the regional flood or will affect the existing drainage courses of facilities."

Levee construction, as proposed, through its encroachment into the floodway, may in fact conflict with the quoted statute section.

The remaining 7,800 feet of the Portage levee extends through Palustrine Forested Wetland (PFW) and Palustrine Emergent Wetland (PEW). Approximately 36 acres of this habitat and its associated wildlife would be eliminated in the 200 foot corridor required for levee renovation. Another major concern with this alignment is that with the project 55 acres of PFW and PEW located between STH 51 and the renovated Portage levee would no longer be flood prone and thus susceptible to urban development (Figure 2). We believe this plan would contravene the letter and spirit of Executive Orders 11988 and 11990 on Floodplain Management and Protection of Wetlands and would be unacceptable to the Service unless the area in question is afforded binding protection to preserve existing wetland wildlife habitat. Therefore, if renovating the Portage levee along its existing alignment is selected as part of the preferred flood control plan, we recommend this parcel be purchased at project cost (including subsequent operation and maintenance costs) as mitigation land to offset project-caused habitat losses. We would also be amenable to other forms of protection which would place the wetland in public reserve, such as permanent easement. The question of what Federal, state, or local agency would be responsible for management of those lands should be resolved during the Advanced Design Phase of project planning, if this alternative alignment is selected.

B. Construct a New Portage Levee

The other portion of Alternative I - Improve the Portage levee includes a new 2,500 foot levee to protect Ward 8 of the city from flooding (Figure 2). As proposed, the levee would begin at STH 33 and extend westward. The Service has no major concerns with this plan as long as the levee is aligned just riverward of existing urban development. This alignment would not disturb appreciably the Palustrine Forested Wetland located adjacent to Pauquette Park and the Wisconsin River

ALTERNATIVE II Ring Dike Around Ward 1 in Portage

During our review of preliminary project information, we designed a levee alignment that could substantially reduce project impacts on fish and wildlife resources. Since it was not included as a Corps' proposed alternative, we presented the ring dike proposal in our Stage II Report as another levee alternative that should be evaluated during Stage III studies.

A. FWS Proposed Ring Dike Alignment

As discussed in our Stage II report dated January 16, 1981 we believe our suggested ring dike alignment around Ward 1 of the city would "conceptually"[2/] alleviate flooding to the majority of residential Portage and still maintain a high degree of environmental protection for the abundant floodplain forests and other wetlands that abut the city. To reiterate, we propose the following alignment for your analysis (Figure 2).

1. Beginning at the Portage Canal, construct the new levee along the existing Portage levee alignment and incorporate our recommended slope modifications for the first 6,000 feet, as previously discussed.

2. Construct a new levee at the junction of STH 51 and Ontario Street; extend it northeast along Ontario Street (just east of the houses) to the Chicago, Milwaukee and St. Paul (C M & St. P) Railroad tracks; continue northwest along the north side of the tracks to Wauona Trail Road and lastly, follow the east side of the road northeast to a point where the levee could tie into STH 33 (2.1 miles of new levee). Floodgates could probably be installed across STH 51 and the C M & St. P. Railroad tracks to avoid raising the road and railroad beds. Highway 33 would probably have to be elevated in the Fox River and Portage Canal area for 100 and standard year flood protection. Much of the land adjacent to the Fox River just northwest of STH 33 between Hamilton Street (north of E. Albert St.) and the Portage Canal is primarily Palustrine Scrub/Shrub wetland; this area should not be flood proofed by levees.

3. Flood proof or evacuate the few scattered unprotected dwellings east of our proposed Ontario St. and Wauona Trail Road levee alignments.

We understand that regardless of which levee alignment is selected, the proposed 1500 foot extension of the Lewiston levee would be necessary to prevent flooding of the city from the west over U.S. Highway 16.

Construction of a ring dike would also fill wetlands. Approximately 51 acres of mainly Palustrine Scrub/Shrub wetland in the Fox River basin would be eliminated by our suggested alignment. However, if this alternative meets other flood control criteria, we believe its merits outweigh the environmental damage for the following reasons.

[2/] We realize the plan must be analyzed for all appropriate flood control criteria besides just environmental considerations.

1. The ring dike would form a boundary separating development from the valuable Fox River wetlands. The observable trend is sporadic filling and continuing encroachment by development eastward into the Fox River wetlands.

2. Again, "conceptually" flood damage to property in Caledonia Township with the project, a serious concern of Caledonia landowners, should be minimized because the Wisconsin River floodplain would not be constricted to the degree proposed by the Portage levee improvements. Rather, floodwater could overtop the existing Portage levee and utilize the water retention capabilities of the Fox River marshes. However, if the Lewiston levee is improved, we presume there would be some flood flow changes in the Wisconsin River channel that could affect Caledonia Township.

3. The wetland located between STH 51 and the existing Portage levee would remain floodprone and thus, not susceptible to development.

If this ring dike alternative were developed the existing Portage levee should be left intact to provide its designed flood protection.

B. Corps of Engineers Proposed Ring Dike Alignment

Although the Corps of Engineers' suggested modification to our ring dike alignment would be shorter, (approximately 1.9 miles of new levee instead of 2.1 miles) the alignment is unacceptable because:

1. The levee would fill most of a 2 acre Palustrine Emergent Wetland (cattail marsh) located in the southeast quarter of Section 21, T12N, R9E (Figure 2).

2. Approximately 25 acres of Palustrine Scrub/Shrub Wetland would remain west or behind the Corps' suggested ring dike which would in all likelihood be displaced by urban development. Taking into account the wetland acreage filled by each levee alignment (FWS:51, CE:45), the FWS's alternative would minimize wetland losses by preserving 19 more acres; 2 of which are Palustrine Emergent Wetlands and 17 are Palustrine Scrub/Shrub Wetlands.

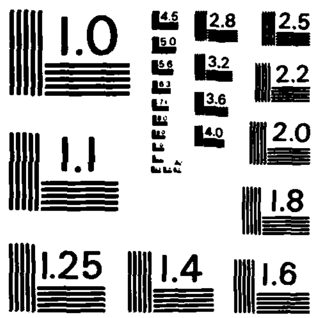
AD-A148 351 FEASIBILITY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT WISCONSIN RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 83 9/9

UNCLASSIFIED F/G 13/2 NL

END

FILMED

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ALTERNATIVE III Improve the Lewiston Levee

This alternative would improve approximately 12,670 feet of the Lewiston levee. On the river side, this stretch of levee is almost entirely bordered by Palustrine Forested Wetland. We understand from your environmental staff that since County Trunk Highway (CTH) O abuts the landward side for almost its entire length, levee renovation would in all likelihood occur riverward. It appears that the loss of approximately 58 acres of bottomland wildlife habitat would be unavoidable with little opportunity for on site mitigation. However, we prefer that levee improvements occur along the existing Lewiston alignment as proposed rather than encroach further into the floodplain where better undisturbed bottomland habitat exists.

ALTERNATIVE IV Lewiston Levee Extension

To prevent flood overflows across U.S. Highway 16, a new 1,500 foot levee is proposed near CTH O about 1 mile east of where the Lewiston levee ends (Figure 2). Assuming the alignment would be as close as possible to CTH O (allowing for avoidance of residential property along the road), no significant adverse effects on wildlife resources are anticipated. Approximately 7 acres of residential property, cropland, and abandoned farm fields would be affected. The fields contain several pockets of sedge meadow mixed with cedar, pine and various shrubs.

ALTERNATIVE V Improve the Portage and Lewiston Levees and Extend the Lewiston Levee

This alternative is a combination of those measures proposed in Alternatives II, III and IV. The overall impact of this alternative on fish and wildlife resources would be the total of those impacts described for each alternative. Therefore, while we envision no major problems associated with work on the Lewiston levee, we have major concerns with the Portage levee portion of the project. Again, several options are available which would minimize project damages to fish and wildlife habitat while providing the desired level of flood protection.

ALTERNATIVE VI Nonstructural Measures

Historically, nonstructural solutions to flooding problems have been under-emphasized resulting in reductions of flood flow capacity and concomitant losses. On a long term basis, nonstructural solutions to flooding are probably the least destructive and best solution for both people, fish, and wildlife. Relative to the problems at Portage, nonstructural solutions may be workable in certain geographic areas of the floodplain and therefore, could be a part of a combination of measures included in the final comprehensive flood control plan for Portage. Nonstructural measures such as floodplain evacuation, zoning to restrict development, and structure floodproofing generally have minimal affects on the floodplain environment. Accordingly, such measures should be used where project costs and/or environmental damage can be reduced.

OTHER PROJECT EFFECTS

Construction Impacts

Since valuable fish and wildlife habitat occurs adjacent to the existing levees, construction impacts are a major concern. Consequently, our comments that follow regarding equipment storage areas, disposal sites, construction access, and borrow areas are intended to help you develop environmentally acceptable plans.

Equipment Storage and Disposal Sites

Filling wetlands to create temporary equipment storage areas is unacceptable. Further, the use of wetlands and floodplains should not be considered for disposal sites for any excess excavated material generated during levee renovation. Rather, upland sites of low wildlife value should be found. For example, there are ample upland fields on the north side of Portage near STH 51 that should be investigated. Also consideration should be given tc the beneficial use of waste material such as stockpiling for garden soil, cover for sanitary landfills, fill for other local construction and sand for roads.

Construction Access

There may be cases during construction where temporarily filling wetlands and floodplains to allow for machinery access is unavoidable. If this situation occurs, the fill must be designed to prevent erosion while in place. Subsequently, all material should be removed immediately after construction; the area restored to its original contour, and seeded with native vegetation or otherwise returned to its preproject condition.

Borrow Areas

Borrow areas for construction fill can involve a sizeable area and result in significant adverse environmental effects if not sited properly. We understand that one area being considered for acquisition of levee construction material is the bed of the Wisconsin River. The effects of in-channel excavation are difficult to predict or control and should be avoided. For exmaple, some adverse impacts that could result downstream from the translocation of a heavy sediment load include: 1) filling riverine wetlands, slack pools, and shallow bays which are the most biologically productive areas of a river, 2) creating depressions in the riverbed that may strand fish and other aquatic life during low water periods and 3) change existing flow patterns causing dewatering of portions of the channel thus eliminating aquatic habitat. Since the work would occur in navigable waters, Federal and state permits would be required and these are typical questions and concerns that would arise during the permit review process. The Service would probably oppose a permit of this type because of the high potential for significant project-induced damages to fish and wildlife resources.

In summary, we recommend that during Advanced Design Planning you screen proposed equipment storage areas, disposal sites, and borrow areas with the WDNR, EPA, the Service and other interested organizations to minimize degradation of fish, wildlife and the habitat upon which they depend.

Levee Maintenance

We are informed that the levees must be maintained in a grass cover to absorb runoff water and prevent bank erosion. Accordingly, with the project, there would be an opportunity to encorage nesting of certain upland game and songbirds. If the levees were planted with suitable vegetation which was allowed to grow long enough to provide dense nesting cover, birds such as ring-necked pheasant, bobwhite and meadowlarks may establish nests.

The destruction of ground nesting birds by agricultural machinery is well known. Egg mortality from spring plowing and brood mortality from cutter blades during early summer harvest can be devastating to bird reproductive success. Therefore, if the levees must be mowed timing is critical. A stipulated condition of the Operation and Maintenance Agreement must prohibit mowing the levees until after August 1, when most bird nesting and brood activity is completed. Otherwise, attempts at passive management of the levees for ground nesting birds would be negated. Further, greater nesting success and better habitat suitability would result if mowing was not conducted every year but rather at 3 to 5 year intervals. Residual cover left from the previous year is critical to early spring nesting and thus, would be much denser if not mowed the previous year.

The type of cover (such as switchgrass, alfalfa or another hay crop) would in part influence the species and numbers of birds that nest on the levees. We recommend that you contact the wildlife manager for the Pine Island State Wildlife Area (Poynette Office, 608-635-4496) for information on the appropriate vegetative plantings. This coordination would insure that levee wildlife management would be compatible with other management objectives occurring in nearby State Wildlife Areas.

ENVIRONMENTALLY SENSITIVE AREAS

Our Stage II report described several environmentally sensitive areas in the project area that should receive special consideration during the development of any flood control plan: the Pine Island and Swan Lake State Wildlife Areas; Baraboo River Floodplain Forest (Natural Area of Statewide Significance); greater sandhill crane nesting habitat; red-shouldered hawk nesting habitat (State Threatened species); speckled chub and black buffalo habitat (State Threatened fish species); and the Leopold Memorial Reserve, a National Historic Landmark administered by the LMR Head Foundation, 201 Waubesa Street, Madison, Wisconsin. With the possible exception as noted below, none of the alternatives as proposed for Stage III study should affect these areas appreciably. However, possible exceptions could involve the following:

1. Habitat damage could result on the Pine Island State Wildlife Area (PISWA) if the Portage and Lewiston levees on the north side of the Wisconsin River were improved without corresponding improvements to the Caledonia levee. The Caledonia levee is located along the south side of the Wisconsin River and separates most of the PISWA from river overflows during high water events (Figure 2). Obviously, without improvements, this levee would be the weak link in the Portage levee system and would probably become overtopped or breached during a major flood. The WDNR has serious concerns with possible flood damage of critical wildlife habitat areas on the PISWA. The effects on the south side of the river

resulting from improving only the north side levees needs further hydraulic and environmental analysis. It may be necessary to develop a mitigation plan for the PISWA particularily if the recommended plan assumes the PISWA would be used as an overflow area. Since WDNR land is involved, close coordination with the Department is paramount during development of a flood control plan for Portage.

2. Alternative locations of disposal sites, equipment storage areas, and borrow areas need to be identified. For example, speckled chub and black buffalo habitat could be degraded if borrow material were excavated from the Wisconsin River channel.

3. The hydraulic effects of the Lewiston levee improvements upon the Leopold Memorial Reserve need to be analyzed.

More information is needed before the Service can assess the impacts upon fish and wildlife resources of items 1 - 3.

ENDANGERED AND THREATENED SPECIES

A review of the Fish and Wildlife Service's "Red Book of Endangered Species" indicates that one listed species, the peregrine falcon (*Falco peregrinus*) is known to occur in Columbia County. This species is a transient during spring and fall migration but potential reintroduction sites along the Wisconsin River have been identified. Typically, these sites occur on cliff or rock outcroppings adjacent to the river.

Our Stage 2 report notes several state listed species of endangered or threatened species known to occur in the study area. We suggest you contact the WDNR Office of Endangered Species in Madison for their assessment of project effects on these organisms.

CONCLUSIONS

In accordance with the U.S. Fish and Wildlife Service's Mitigation Policy[3/], we classify affected habitats in Resource Category 3: "Habitat to be impacted is of high to medium value to evaluation species and is relatively abundant on a National basis" (possible exceptions are Palustrine Forested and Palustrine Emergent Wetlands; however, locally they are relatively abundant). Accordingly, our mitigation goal is no net loss of habitat value while minimizing loss of in-kind habitat value. If losses are likely to occur, they should be rectified immediately, reduced or eliminated over time. Mitigation in this category could also involve compensation by replacement of habitat lost with the project, although not necessarily on an acre for acre basis.

Our suggested mitigation plans to minimize adverse impacts upon fish and wildlife resources are shown, by alternative, in Table 2.

[3/] Published in the Federal Register, Vol. 46, No. 15, Friday, January 23, 1981.

Table 2 - Fish and Wildlife Service mitigation measures by alternative

Alternative	Mitigation Recommended
I. Improve the Portage levee along existing alignment; including a new levee along Ward 8 of the city.	Ia. Purchase at project cost the 55 acres of wetland wildlife habitat located between STH 51 and the existing Portage levee.
	Ib. Modify the Portage levee riverward slope to 1:1 along Ward 8 and from the Portage Canal to 1.1 miles downstream.
	Ic. Where possible, expand the levee landward rather than riverward to minimize levee encroachment into the floodplain.
	Id. Allow the grass cover on the levees to remain unmowed until after August 1, when most bird nesting and rearing activity is over. Also, mow every 3-5 years to allow dense nesting cover to become established, rather than annual mowing.
II. Ring dike around Ward 1 of the city.	IIa. Follow FWS suggested alignment.
	IIb. Incorporate items Ib, Ic, and Id above.
III. Improve the Lewiston levee	IIIa. Incorporate items Ic and Id above.
IV. Extend the Lewiston levee	IVa. Align the levee as close as possible to CTH O
	IVb. Incorporate items Ic and Id above.
V. Improve the Portage and Lewiston levees and extend the Lewiston levee along existing alignments	Va. Incorporate items Ia through Id above.
VI. Nonstructural Measures	VIa. Incorporate nonstructural flood prevention measures such as floodplain evacuation, zoning, and flood proofing into the recommended plan in those areas of the floodplain where structural costs and/or environmental damage could be reduced.

RECOMMENDATIONS

1. The FWS suggested ring dike around Ward 1 of the city (Alternative IIA) is the best structural plan to minimize adverse impacts to fish and wildlife resources.

2. If the selected plan includes improving the Portage levee along its existing alignment, the 55 acres of wetlands located between STH 51 and the existing Portage levee should be purchased at project cost, as mitigation lands to compensate for project caused losses. Other options to place the wetlands in public reserve besides acquisition could be investigated. Without this stipulation the Service would probably oppose implementation of this alternative.

3. To avoid excessive filling in the Wisconsin River channel by reconstruction of the Portage levee in the city (Portage canal to approximately 1.1 miles downstream), appropriate structural design modifications must be incorporated to allow for a 1:1 riverward slope or as near to that as feasible. This would also apply to the new levee proposed along Ward 8 of the city.

4. Wherever possible, the existing levees should be widened landward rather than riverward to retain the maximum amount of functional floodplain.

5. Borrow sites and equipment storage areas must be located on upland sites outside of environmentally sensitive areas. Disposal sites for unusable excavated material must be similarly located. Interagency coordination among the Service, WDNR and EPA must occur during advanced design planning to select acceptable sites commensurate with Federal, state and local rules and regulations.

6. Unavoidable wetland fills for construction access should be restored to the original wetland contour immediately after project completion.

7. If the levees must be mowed it should occur on a 3 to 5 year cycle. In any event, mowing must not occur prior to August 1.

8. Changes in flood stage of the Wisconsin River resulting from proposed improvements to the Lewiston levee must be analyzed in terms of their effects on the Leopold Memorial Reserve. Particularily, levee improvement on the north side of the river must be designed to avoid flooding the historic Leopold cabin located on the south side of the river. The Service would likely oppose any plan that would physically modify or otherwise degrade the Reserve.

We trust this report and our previous correspondence (April 1, 1977, May 5, 1977, February 1, 1979, and January 16, 1981) will help your analysis of a feasible flood control plan and look forward to providing future input in the development of an environmentally acceptable plan.

Sincerely yours,

James L. Smith
Acting Area Manager

cc: Bill Tans, Bureau of Environmental Impact, DNR, Madison, WI
Barbara Taylor, US EPA, Chief, Environmental Impact Review Staff, Chicago, IL

LIST OF PREPARERS

James D. Fossum (principal preparer), Fish and Wildlife Biologist, Green Bay Field Office, B.A. in Biology - 1969, Winona State University, Winona, Minnesota. M.S. in Biology - 1975, St. Mary's College, Winona, Minnesota

Nevin D. Holmberg, Field Supervisor of the Green Bay Field Office, Green Bay Wisconsin, B.S. in Wildlife Management - 1969, Humboldt State University, Arcata, California. M.S. in Wildlife Management - 1975, Humboldt State University, Arcata, California

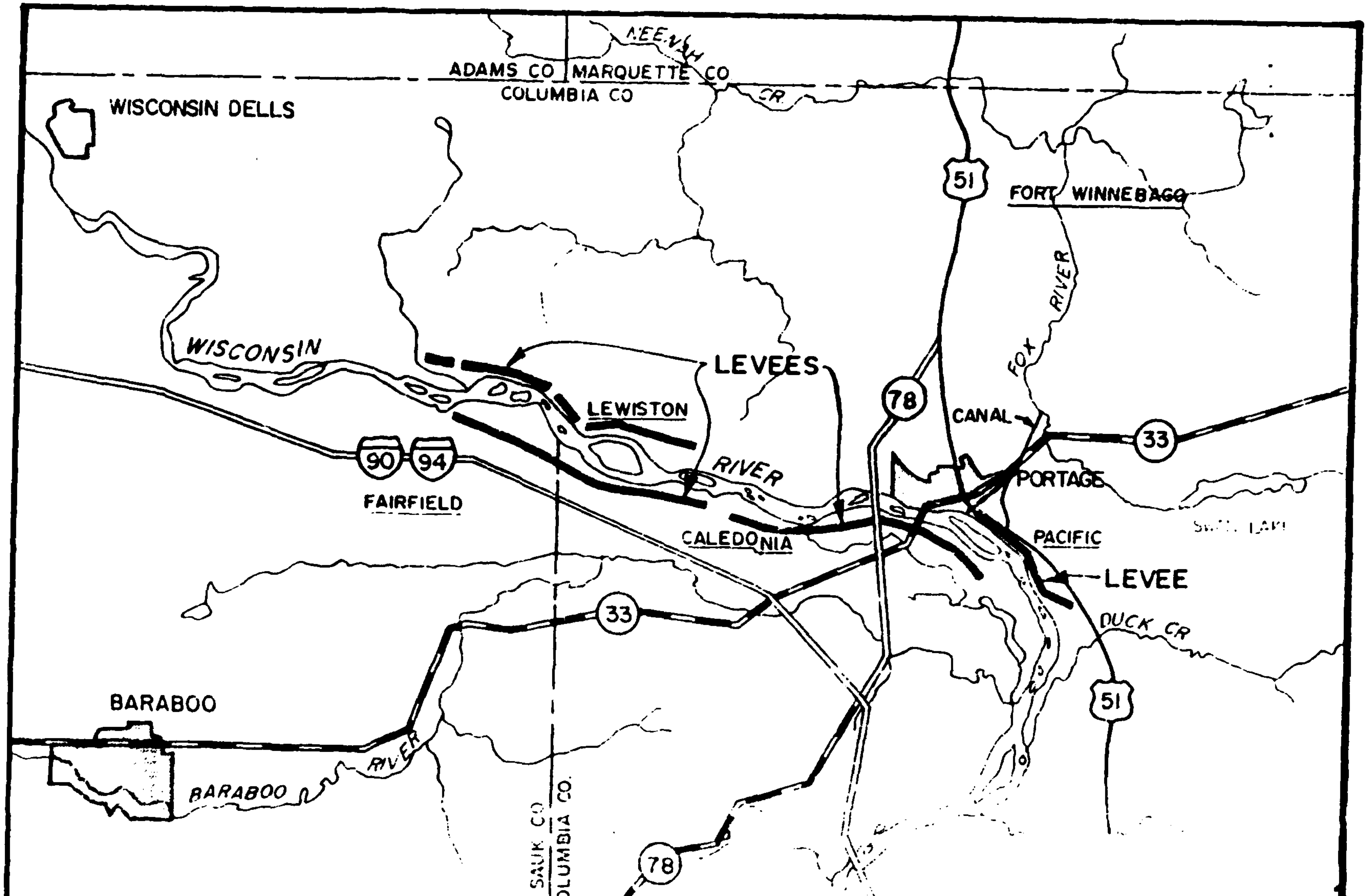


Figure 1. THE PORTAGE AREA.

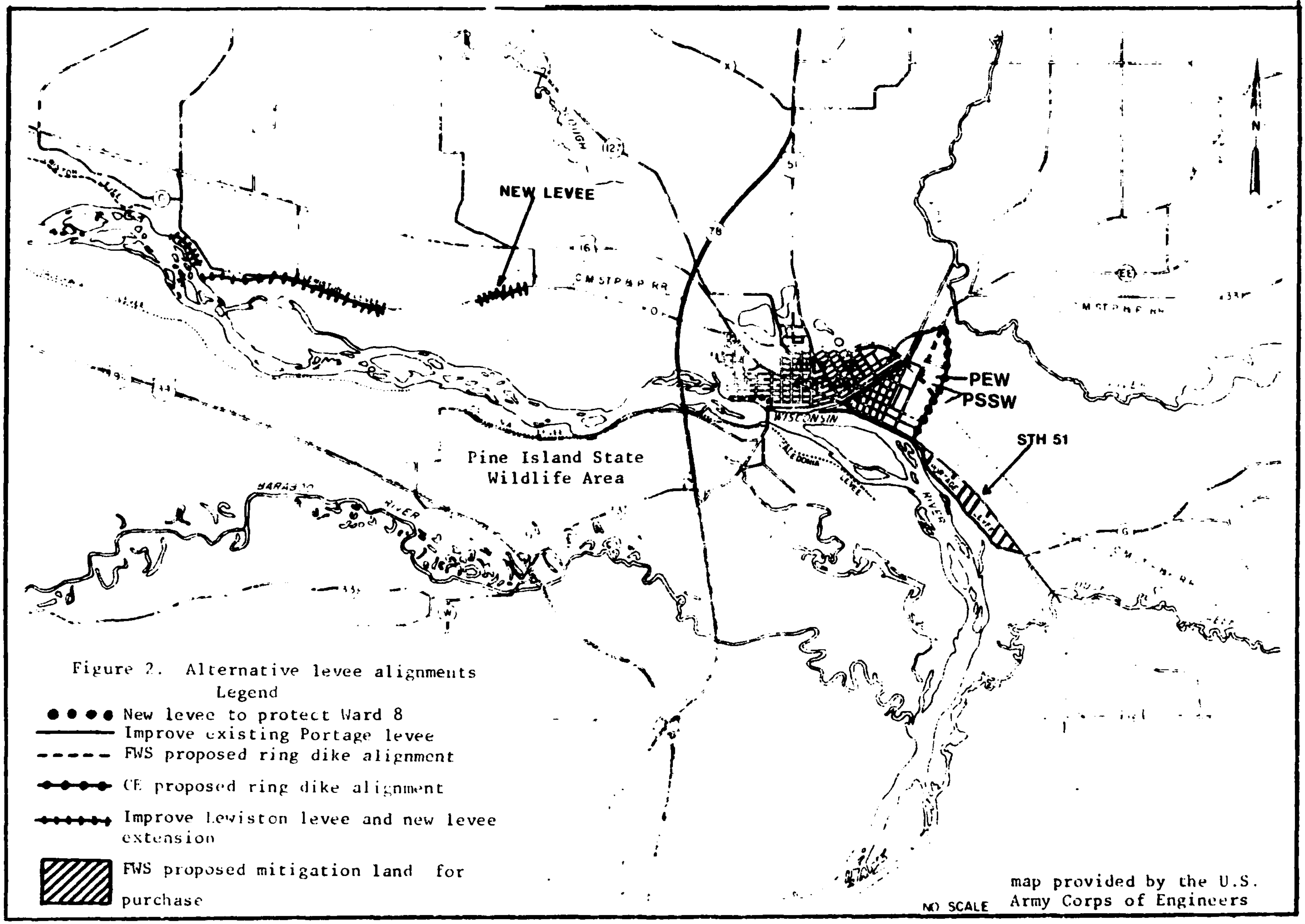


Figure 2. Alternative levee alignments

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB

21 January 1982

This letter provides an update on the Wisconsin River at Portage, Wisconsin, feasibility study. We are working on the hydrology, hydraulic, and soil analyses needed for the design of flood damage reduction plans. We will be conducting an institutional analysis to assist potential non-Federal sponsors.

Alternative flood damage reduction plans include:

1. Raising and widening the Portage levee.

2. Raising and widening the Portage levee and a portion of the Lewiston levee.

3. Constructing a ring levee to protect Ward 1 in Portage.

We will also determine ways to make the Portage Canal more attractive, primarily at the Wisconsin River lock.

The study completion date has been delayed 13 months because of increased requirements and costs for technical studies such as soil, design, and environmental analysis. The current schedule is as follows:

Draft feasibility report (Corps review)	March 1983
Coordination of draft report (public review)	July 1983
Final report to the public	February 1984

We will keep you informed of study progress. If you have any questions, please call or write. Mr. John Bailen (612-725-7494) is the study manager.

Sincerely,

WILLIAM W. BADGER
Colonel, Corps of Engineers
District Engineer

Dennis Mahy, Forester
Dept. of Natural Resources
Box 139
County Admin. Building
Portage, WI 53901

Mr. Bob Roden, Director
Bureau of Water Regulation &
Zoning, Dept. of Natural
Resources, Box 7921
Madison, WI 53707

Hon. Everett V. Bidwell
State Senator, 27th District
612 Edgewater Street
Portage, WI 53901

Hon. Tom G. Thomson
State Representative
State Capitol-Rm 205 West
79th Assembly District
Madison, WI 53702

Orrin Anderson, Chairman
Columbia County Board of
Supervisors, Columbia County
Administration Building
Portage, WI 53901

Chairman, Zoning & Planning
Committee for Columbia County
County Administration Bldg.
Portage, Wisconsin 53901

Mr. Bob Irwin, Dir. of Planning
& Zoning for Columbia County
County Administration Bldg.
Portage, WI 53901

Chairman
Sauk County Board of
Supervisors, Sauk County
Courthouse
Baraboo, WI 53913

Gene Golke, Direcotr
Columbia County Emergency
Government
Sheriff's Dept.
Portage, WI 53901

Mr. Kenneth Cummings
Chairman, Town of Fairfield
Route 1
Baraboo, WI 53913

Hon. Robert Mael
Mayor of Portage
115 West Pleasant Street
Portage, WI 53901

Mr. Francis W. Murphy
City Attorney
234½ West Wisconsin Street
Portage, WI 53901

Mr. Dick Smith
1st Ward Alderman
210 Brook Street
Portage, WI 53901

Mr. Michael Horkan
Dir. of Public Works
115 West Pleasant Street
Portage, WI 53901

Mr. Leon Heinze, Chairman
Town of Lewiston
Route 3
Portage, WI 53901

Mr. Lester Lehman, Chairman
Town of Caledonia
Route 2
Portage, WI 53901

Mr. Elvin Horton, Chairman
Town of Pacific
Route 2
Pardeeville, WI 53954

Mr. Chris Schroeder, Chairman
Town of Fort Winnebago
Route 1
Portage, WI 53901

Mr. Elmer Fisk, Chairman
Town of Dekorra
Route 1
Poynette, WI 53955

Editor
Portage Register
309 DeWitt Street
Portage, WI 53901

Mr. Ed Kramer, President
WPDR Radio Station
Box 1350
Portage, WI 53901

Larry Larson, Chief, Floodplai
Shoreland Mgmt. Sec.
Dept. of Natural Resources
Box 7921
Madison, WI 53707

Mr. Otto Festge
Home Sec. to Congressman Robert
W. Kasternmeier
P.O. Box 1625
Madison, WI 53701

Harold O. Vik
Box 340
Portage, WI 53901

Mr. Henry Abraham, President
Portage Canal Society
529 West Cook Street
Portage, WI 53901

Hon. Robert W. Kastenmeier
U.S. House of Representatives
Washington, D.C. 20515

Hon. William S. Proxmire
United States Senate
Washington, D.C. 20510

Hon. Robert Kasten
United States Senate
Washington, D.C. 20510

Mr. Nevin D. Holmberg
Field Supervisor, Green Bay Off
U.S. Fish & Wildlife Service
Univ. of Wisconsin - Green Bay
Green Bay, WI 54301

NCSED-PB 25 February 1982

Mr. Lester Lehmann
Chairman, Town of Caledonia
R. 2, Box 115
Portage, Wisconsin 53901

Dear Mr. Lehmann:

This is in reply to your letter of 11 February 1982 concerning the Wisconsin River at Portage flood control study. Raising and widening the Caledonia levee was considered in our study. However, the flood damage reduction benefits to farmland and the relatively few buildings that would be protected are far less than the costs of improving the 9½-mile-long levee. Since the Corps cannot construct a project unless the benefits exceed the costs, we have no further plans to improve the Caledonia levee. We believe, however, the Wisconsin Department of Natural Resources will continue to provide maintenance on the Caledonia levee.

If you have further questions please feel free to contact us.

Sincerely,

LOUIS KOWALSKI
Chief, Planning Branch
Engineering Division

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

March 16, 1982 IN REPLY REFER TO:

Colonel William W. Badger
District Engineer
U.S. Army Corps of Engineers
St. Paul District
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

RE: Portage, Wisconsin Feasibility Study, Wisconsin River

My staff has reviewed your letter of January 21, 1982, advising interested participants of the revised study schedule. We appreciate you alerting us to this revised schedule in a timely fashion.

I am concerned, however, about the alternatives that have been identified for reducing flood damage potential. Each of the three alternatives under consideration, are structural alternatives involving some form of levee. We strongly urge that nonstructural alternatives be given equal and fair evaluation which, in our view, would enhance the credibility of this feasibility study.

Greater use of nonstructural flood mitigation alternatives, we believe, is reinforced by recent messages emanating from Washington. Projects will no longer be entirely federally subsidized and, in fact, the nonfederal share may increase to as much as 50%. Since the state has been asked to co-sponsor this project, we believe a very careful and detailed feasibility of nonstructural alternatives should be incorporated in this evaluation study.

Please feel free to contact Mark Riebau at (608) 266-2709 if you have questions or comments on our views.

Sincerely,

CD Besadny

C. D. Besadny
Secretary

cc: Governor Dreyfus
Ken Lindner - DOA

1595K

NOV 5 1982

NCSPD-ER

Mr. Richard A. Erney
State Historic Preservation Officer
State Historical Society of Wisconsin
816 State Street
Madison, Wisconsin 53706

Dear Mr. Erney:

Since our last correspondence about the flood control project at Portage, Wisconsin, the St. Paul District, Corps of Engineers, has better identified the preliminary levee alignments for the study area. We have identified several new areas that would require some type of levee construction, and we have determined the possible nature and location of levee construction involving the Portage Canal and Wauona Trail. The inclosed maps show the various alternative alignments for levee improvement as well as the general locations where the canal would be affected.

The three new areas where levees are being considered are located west and southeast of Portage. The first area is on the western edge of the city and would connect the southern end of Summit Street with the western end of Carroll Street (see inclosures 1-7). This proposed levee would provide flood protection up to the 801.4-foot contour for the 100-year flood and up to the 803.2-foot contour for the standard project flood (SPF).

The second area begins southeast of the intersection of Ontario and East Wisconsin Streets. Instead of following the existing Portage levee, the new alternative follows along the south side of U.S. Highways 16 and 51 to the intersection with County Road G (see inclosures 2 and 4).

The third new area under consideration is northwest of Portage. This area would only be developed under SPF conditions (without the ring levee) as part of the Lewiston levee system (see inclosures 3 and 4). This levee would follow along the south side of the Chicago, Milwaukee, St. Paul and Pacific Railroad from near the SW¼, NW¼ of Section 33, T. 13 N., R. 8 E., to the NW¼, SW¼ of Section 34, T. 13 N., R. 8 E. (Pine Island, Wisconsin, 7.5-minute quadrangle).

The width of the levees would vary from 85 to 160 feet, depending on the degree of flood protection provided. In addition, some areas would require construction of berms landward of the levee to prevent foundation problems caused by seepage through the levees. These berms would vary in width from 100 to 250 feet, again depending on the degree of protection. Areas requiring

a berm include the levee located downstream of Ontario Street, upstream in the Lewiston area, and for the ring levee around the Ward 1 area. The remainder of the Portage levee between Summit and Ontario Streets would be constructed riverward and would rely on relief wells rather than a berm.

So that the levee system can provide a reasonable degree of flood protection, the Portage Canal must be crossed at least once and possibly twice. Regardless of the alternative chosen, the Wisconsin River end of the canal would be incorporated into the levee system. The most cost-effective method of doing so, at present, appears to be extending the Portage levee across the mouth of the canal (see inclosure 7). At a minimum, a gatewell would be located on the levee to permit a source of fresh water for the canal. We are also considering some sort of closure structure in the levee to keep the canal functional.

The construction of either ring levee alternative would require crossing the canal in a second location. Under Alternative 3, the crossing would be just southwest of the Chicago, Milwaukee, St. Paul and Pacific Railroad bridge. Under Alternative 3a, the crossing would be on the southwest side of the Highway 33 bridge (see inclosures 5-7). Water quality and water transportation aspects of the crossing are likewise being considered.

Because the St. Paul District is aware of the National Register significance of the Portage Canal, we are considering alternatives that would reduce any adverse effects. This office is examining the possibility of incorporating the Wisconsin River locks into the levee. However, such an alternative would involve rebuilding a major portion of the locks and raising the structure approximately 2.6 feet above the existing ground level on the south side of the locks to protect against the 100-year flood condition and about 4.0 feet to protect against the standard project flood condition. Although the reconstructed locks could be made to resemble the original lock or some other form that the lock had in the past, the visual impacts would be significant. The Corps is determining the additional costs attributable to historic preservation from lock reconstruction or from levee construction that could maintain the functional use of the canal.

In addition to the canal, ring levee construction would impact the Wauona Trail, also on the National Register. Alternative 3 requires that the trail be crossed and closed near the Morgan Street intersection (see inclosures 5 and 7). Alternative 3a (inclosures 6 and 7) calls for levee construction along the trail from about Morgan Street to a point south of the Highway 33 bridge where the levee then crosses and closes the trail. Given the current state of the Wauona Trail (a tarred road), the adversity of the impacts is not clear.

NCSPD-ER
Mr. Richard A. Erney

NOV 5 1982

The St. Paul District would appreciate your comments on these aspects of the Portage flood control project and your determination of effect in accordance with the regulations of the Advisory Council on Historic Preservation (36 CFR Part 800 Section 5). Please address the nature of the effects that you expect: visual, physical, or other. The Corps is open to suggestions on the types of mitigation that may be employed if levee construction must close the lock or canal. If you have any questions, please contact David E. Berwick of my staff at (612) 725-7854. Thank you.

Sincerely,

7 Incl
As stated

WAYNE A. KNOTT
Chief, Environmental Resources Branch
Planning Division

3

NOV 5 1982

NCSPD-ER

Dr. Joan Freeman
State Archeologist
State Historical Society of Wisconsin
816 State Street
Madison, Wisconsin 53706

Dear Dr. Freeman:

Since our last correspondence about the flood control project at Portage, Wisconsin, the St. Paul District, Corps of Engineers, has better identified the preliminary levee alignments for the study area. We have identified several new areas that would require some type of levee construction, and we have determined the possible nature and location of levee construction involving the Portage Canal and Wauona Trail. The inclosed maps show the various alternative alignments for levee improvement as well as the general locations where the canal would be affected.

The three new areas where levees are being considered are located west and southeast of Portage. The first area is on the western edge of the city and would connect the southern end of Summit Street with the western end of Carroll Street (see inclosures 1-7). This proposed levee would provide flood protection up to the 801.4-foot contour for the 100-year flood and up to the 803.2-foot contour for the standard project flood (SPF).

The second area begins southeast of the intersection of Ontario and East Wisconsin Streets. Instead of following the existing Portage levee, the new alternative follows along the south side of U.S. Highways 16 and 51 to the intersection with County Road G (see inclosures 2 and 4).

The third new area under consideration is northwest of Portage. This area would only be developed under SPF conditions (without the ring levee) as part of the Lewiston levee system (see inclosures 3 and 4). This levee would follow along the south side of the Chicago, Milwaukee, St. Paul and Pacific Railroad from near the SW¼, NW¼ of Section 33, T. 13 N., R. 8 E., to the NW¼, SW¼ of Section 34, T. 13 N., R. 8 E. (Pine Island, Wisconsin, 7.5-minute quadrangle).

The width of the levees would vary from 85 to 160 feet, depending on the degree of flood protection provided. In addition, some areas would require construction of berms landward of the levee to prevent foundation problems caused by seepage through the levees. These berms would vary in width from 100 to 250 feet, again depending on the degree of protection. Areas requiring

a berm include the levee located downstream of Ontario Street, upstream in the Lewiston area, and for the ring levee around the Ward 1 area. The remainder of the Portage levee between Summit and Ontario Streets would be constructed riverward and would rely on relief wells rather than a berm.

So that the levee system can provide a reasonable degree of flood protection, the Portage Canal must be crossed at least once and possibly twice. Regardless of the alternative chosen, the Wisconsin River end of the canal would be incorporated into the levee system. The most cost-effective method of doing so, at present, appears to be extending the Portage levee across the mouth of the canal (see inclosure 7). At a minimum, a gatewell would be located on the levee to permit a source of fresh water for the canal. We are also considering some sort of closure structure in the levee to keep the canal functional.

The construction of either ring levee alternative would require crossing the canal in a second location. Under Alternative 3, the crossing would be just southwest of the Chicago, Milwaukee, St. Paul and Pacific Railroad bridge. Under Alternative 3a, the crossing would be on the southwest side of the Highway 33 bridge (see inclosures 5-7). Water quality and water transportation aspects of the crossing are likewise being considered.

Because the St. Paul District is aware of the National Register significance of the Portage Canal, we are considering alternatives that would reduce any adverse effects. This office is examining the possibility of incorporating the Wisconsin River locks into the levee. However, such an alternative would involve rebuilding a major portion of the locks and raising the structure approximately 2.6 feet above the existing ground level on the south side of the locks to protect against the 100-year flood condition and about 4.0 feet to protect against the standard project flood condition. Although the reconstructed locks could be made to resemble the original lock or some other form that the lock had in the past, the visual impacts would be significant. The Corps is determining the additional costs attributable to historic preservation from lock reconstruction or from levee construction that could maintain the functional use of the canal.

In addition to the canal, ring levee construction would impact the Wauona Trail, also on the National Register. Alternative 3 requires that the trail be crossed and closed near the Morgan Street intersection (see inclosures 5 and 7). Alternative 3a (inclosures 6 and 7) calls for levee construction along the trail from about Morgan Street to a point south of the Highway 33 bridge where the levee then crosses and closes the trail. Given the current state of the Wauona Trail (a tarred road), the adversity of the impacts is not clear.

NOV 5 1982

NCSPD-ER
Dr. Joan Freeman

The St. Paul District would appreciate your comments on these aspects of the Portage flood control project by 22 November 1982 so that we can maintain our current schedule. If you have any questions, please contact David E. Berwick of my staff at (FTS or 612) 725-7854. Thank you.

Sincerely,

Knott

WAYNE A. KNOTT 5 NOV 1982
Chief, Environmental Resources Branch
Planning Division

4 Incl
As stated

Identical letter to:
Dr. Jack Rudy
National Park Service

HISTORIC PRESERVATION DIVISION

December 13, 1982

Mr. Wayne A. Knott
Chief, Environmental Resources Branch
Planning Division
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

SHSW: 783-82
RE: City of Portage
Flood Control Project

Dear Mr. Knott:

As requested in your letter of November 5, 1982, our staff has reviewed the proposed alternatives for flood control at Portage, Wisconsin, to determine what effect the project might have on the Portage Canal and Wauona Trail.

Regardless of which alternative is selected, the project will have an adverse effect on the canal. Construction of a levee across the Wisconsin River end of the canal would result in the irreparable alteration of the lock there and would introduce visual elements out of character with the canal and its setting. Further, alternatives 3 and 3a, which require crossing the canal at a second location, would effectively make the canal inoperable and isolate the northern and southern halfs of the canal.

Alternatives 3 and 3a would also have an adverse effect on Wauona Trail as they would isolate the northern and southern halves of the trail and would introduce visual elements out of character with the trail and its setting.

We feel that it would be premature to begin considering mitigation measures before a final alternative is selected and more information is available regarding the design of the levees. We do, however, recommend that the Corps begin consultations with the Advisory Council by providing them information on the history of the project and on the preservation issues involved.

As discussed with your staff at our meeting in Madison on November 30, additional work is required to determine whether there are other properties in the project area that may be eligible for

THE STATE HISTORICAL SOCIETY OF WISCONSIN
816 STATE STREET · MADISON, WISCONSIN 53706 RICHARD A ERNEY, DIRECTOR

the National Register. It is my understanding that the Corps of Engineers have already surveyed most of the proposed levee alignments for archeological sites and that surveys have been scheduled for the remaining alignments. Copies of the reports for these surveys should be forwarded to our office for our review and comments. Additional work is also needed to identify those individual structures and districts within the project area that may be historically or architecturally significant.

If you have any questions on this matter, please contact me at (608) 262-2732.

Sincerely,

Richard W. Dexter

Richard W. Dexter
Chief, Registration & Compliance
Section

RWD:lkr

cc: Mr. Michael Quinn, Advisory Council on Historic Preservation
Ms. Frederica Kleist, Portage Canal Historical Society

CITY OF PORTAGE

"Where the North Begins"

PORTAGE, WISCONSIN
53901

OFFICE OF
DEPARTMENT
OF PUBLIC WORKS

December 17, 1982

Department of the Army
St. Paul District Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, MN 55101

Attn: Chuck Chris

Re: Status Report on Evaluation of Alternatives, Portage, Wisconsin, Feasibility Study

Pursuant to the Corp of Engineers' presentation on their status report on the Evaluation of all alternatives in the Feasibility Study at Portage, Wisconsin and your update on that particular evening which exposed the Common Council of the City of Portage to alternatives recommended for further study. The alternatives recommended for further study included the following: (1) the improvement to Portage levees, (2) improvement to Portage and Lewiston levees, and (3) non-structural measures. As you are aware, the Common Council of the City of Portage took no action on the evening of December 9th, 1982. However, the Common Council of the City of Portage did meet on December 13th, 1982 and recommended that the Corp of Engineers strongly consider alternate number one which is the improvement to the Portage levees. Attached to this letter is a copy of the December 13th, 1982 Common Council minutes which discusses the feasibility study under old business.

In summary, the City of Portage Common Council supports the efforts of the Corp of Engineers in improving the Portage levee and recognizes a benefit to the City of Portage. If questions concerning the council minutes of December 13th, 1982 or this letter arise, please contact this office at (608) 742-2595.

Sincerely,

Michael T. Horkan

Michael T. Horkan, P.E.
Director of Public Works

MTH:cc

Enc.

PUBLIC HEARING ON 1983 CITY BUDGET AND PROPOSED USE OF FEDERAL REVENUE SHARING FUNDS

Hearing called to order by Acting Mayor Franklin A. Maas on December 13th, 1982, at 7:00 P. M. Present were the Alderpersons, Department Heads, representatives of the news media, and interested citizens. The Clerk read the Notice of Public Hearing and stated that the notice had been published in the Portage Daily Register on November 23rd, 1982.

Acting Mayor Maas invited the citizens present to speak on the budget. None spoke. After all persons present had had a chance to be heard, Acting Mayor Maas declared the public hearing closed at 7:04 P. M.

Alma M. Braun
Alma M. Braun, City Clerk

Regular Meeting | COMMON COUNCIL PROCEEDINGS | December 13th 1982
Council Chambers
City Municipal Building | CITY OF PORTAGE | 7:05 P. M.

The meeting was called to order by Acting Mayor Franklin A. Maas.

Roll Call: Present: Alderpersons Anacker, Detert, Hoffer, Little, Maas, Maurer, Murphy, Ortman, and Welsh. (9) City Attorney Sulna.

COMMUNICATIONS

A letter from U S Cable of Viking re payment of third quarter franchise fee was read and filed.

REPORTS

The minutes of the Police and Fire Commission meeting of December 8th, 1982, were discussed and filed.

ORDINANCES

Insert #1 - Ordinance No. 1222 relative to holidays and expense allowances received its first and second readings. Welsh moved to suspend the rules for the third reading of Ordinance No. 1222 by title only. This motion was seconded by Welsh, and carried on call of roll. Ordinance No. 1222 received its third reading by title only and was passed on motion by Ortman, seconded by Detert, and call of roll.

Insert #2 - Ordinance No. 1223 relative to personnel received its first and second readings. Welsh moved to suspend the rules for the third reading of Ordinance No. 1223 by title only. This motion was seconded by Maurer and carried on call of roll. Ordinance No. 1223 received its third reading by title only and was passed on motion by Maurer, seconded by Welsh, and call of roll, 8 yes 1 no, Detert voting no.

RESOLUTIONS

Insert #3 - Resolution No. 3647 relative to ambulance service was read and adopted on motion by Welsh, seconded by Little, and call of roll.

Insert #4 - Resolution No. 3648 relative to City Hall Bond Issue was read. Maurer moved to amend Resolution No. 3648 by changing the word "may" in the third line from the bottom on page 1 to "shall". This motion was seconded by Hoffer, and carried on call of roll. Ortman moved to adopt Resolution No. 3648 as amended. This motion was seconded by Detert, and carried on call of roll.

Insert #5 - Resolution No. 3649 relative to Taxation was read and adopted on motion by Hoffer, seconded by Welsh, and carried on call of roll, 8 yes, 1 no, Detert voting no.

END

FILMED

1-85

DTIC